᾽# NATURAL SCIENCE:

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NOTES AND COMMENTS.

Education by Experiment.

THE young human animal is born into this world with a great curiosity and a great desire for knowledge. It longs to touch, to taste, to try in every way the properties of things around it. On its lips is from the first the catch-word of our race, the everlasting "Why?" What do we do with this inquisitive creature? We box it up in a room and set it to learn the A B C; we cramp its flexible hands with a pen; we dull its brain with verses and the multiplication table, both learned by rote; we tell it not to be tiresome and sternly repress all child-like efforts to see the wheels go round. Thus the great work of education progresses: mountains and rivers are learned in lists, sums are done by rule, geometry is repeated as an effort of memory. Then the boy, and sometimes the girl, must learn physical science. Soon he will know the laws of heat, the composition of the spectrum, the names and atomic weights of the elements, the succession of geological formations, and the classification of the animal and vegetable kingdoms; but he cannot get a fire to light, is ignorant that a tadpole turns into a frog, and gives himself a stomach-ache with a poisonous fungus. As for poor science, it is called "Stinks," and the teachers of it are naturally despised. The youth is turned out an ignorant prig or a learned trifler, the country goes to the dogs, and even the toys of the next generation are "made in Germany."

Thus we write to-day; but three centuries ago Montaigne said the same thing: "Seeing how we are taught, what wonder is it that neither pupils nor masters become more able, although they make themselves more learned. In truth, the care and expense of our fathers serve but to furnish our heads with knowledge; of judgment and virtue small news is there. . . . The question should be, whose learning is the best, not whose is the greatest." And yet it moves. Our children, if not ourselves, have already the benefit of a far more

rational system of education; one that does really lead out and train up the natural faculties of the race and of the individual, instead of coldly crushing them.

Much, however, remains to be done—in the teaching of Natural Science, quite as much as in other subjects. We must not make a bogey of Nature, but a friend, one with whom our children can converse, whom they can question for themselves, and whose tales they may delight to hear. Of course, the old way was easier—for the teacher. The new way takes time, and its results will at first be hard to estimate in either marks or money. At the outset teachers must be taught and examiners instructed; we all want a guide.

With the hour has come the man. Our guide waits for us in the person of Mr. Hugh Gordon, the science demonstrator to the London School Board; while as a guide-book we have his "Elementary Course of Practical Science," of which part i. has just been issued by Messrs. Macmillan at the price of one shilling. This is a book to excite enthusiasm in the heart of every teacher worthy of his post. Slight though it be, it is a step, and a long step too, in the right direction. Mr. Gordon's method is the method of Nature; he would educate the child as Nature has educated the race. Take nothing for granted! Ask "Why?" Try for yourself! Prove each step! Be clean, careful, accurate! Check your results! Such are the precepts that Mr. Gordon shows us most admirably how to put into practice. Exactly how he does this we do not intend to divulge. The book, though it would take many weeks to work through, can be read in less than an hour; and no hour could be better spent by all who, whether as parents or teachers, have the inestimable privilege of bringing young minds into touch with this wide and wonderful world.

Mathematical Biology.

A DISTINCTION is often drawn between the exact sciences and the natural history sciences, on the ground that only the former are capable of mathematical expression and demonstration. Attempts have of course been made at different times to subject the growth or the form of animals and plants to mathematical analysis; but, as a rule, the amount of variation that is so characteristic of living beings has baffled the enquirer. Now, however, observers are attacking the elusive quantity itself, and endeavouring to define it in terms of mathematical precision. The last number of the *Proceedings of the Royal Society* contains two remarkable papers bearing on this subject. The one is "On certain Correlated Variations in *Carcinus mœnas*" by Professor W. F. R. Weldon; the other, "Contributions to the Mathematical Theory of Evolution" by Professor Karl Pearson.

It is recognised that no two animals are exactly the same, and that their organs vary irregularly. Professor Weldon has, however,

shown "(1) that the observed deviations from the average size of every organ measured are grouped symmetrically about the average, and occur with a frequency corresponding closely to that indicated by the probability integral; and (2) that the 'degree of correlation' between a given pair of organs is approximately the same in each of five local races of the species." (*Proc. Roy. Soc.*, vol. xlvii., p. 445; and vol. li., p. 2). He has now measured specimens of the shore crab in two lots, one from Naples and the other from Plymouth, and after an elaborate comparison of the correlated variations between different organs, he shows that, though variation may differ, yet the amount of *correlation* is the same for both groups.

The method followed by Professor Weldon in determining the degree of correlation between two organs was that proposed by Mr. Francis Galton in his paper on Family Likeness in Stature (*Proc. Roy. Soc.*, vol. xl., pp. 42–63), and it appears that the results obtained by that ingenious anthropometer are fully confirmed by the study of so remote a group as the Arthropoda. The suggestion has recently been made that "the method of composite portraiture, as developed by Mr. Francis Galton and others, might be employed with advantage to discover a type or standard from which degrees of variation within the limits of a species might be measured in positive or negative terms" (Bather, "Crinoidea of Gotland," p. 5). This, perhaps, is often impracticable, but the construction of a diagram from the average of numerous measurements would serve a similar purpose. Such a diagram of the carapace of the crabs in question is actually given by Professor Weldon. The diagram is drawn to scale, the right half representing a perfectly average Plymouth crab and the left an average crab from Naples.

Professor Pearson's contribution to the subject is a mathematical analysis of certain curves that may be constructed from a series of measurements of a number of objects of the same type. Such curves, which he terms *frequency curves*, are often abnormal, especially in biological measurements, such as those of Professor Weldon, or the similar ones of Thompson for prawns, and Bateson for earwigs. Although abnormal, however, they are subject to certain laws, and from a consideration of these Professor Pearson believes it possible to detect whether the individuals measured represent a mixture of two heterogeneous groups, or whether they represent one homogeneous species gradually being evolved into two differentiated species. Thus he finds that the Naples crabs are all of one species, but that they are breaking up into two varieties owing to evolution in their foreheads. Mr. Thompson's prawns, on the other hand, either have a small percentage of individuals deformed in the carapace, or else have a small but unstable giant population mixed with the normal population.

These modern mathematical investigations differ widely from the fine-drawn and metaphysical "pro-morphology," as Geddes calls it, of the old German nature-philosophers. As to their value, hear Pro-

fessor Weldon:—"It cannot be too strongly urged that the problem of animal evolution is essentially a statistical problem: that before we can properly estimate the changes at present going on in a race or species we must know accurately (*a*) the percentage of animals which exhibit a given amount of abnormality with regard to a particular character; (*b*) the degree of abnormality of other organs which accompanies a given abnormality of one; (*c*) the difference between the death rate per cent. in animals of different degrees of abnormality with respect to any organ; (*d*) the abnormality of offspring in terms of the abnormality of parents, and *vice versâ*. These are all questions of arithmetic; and when we know the numerical answers to these questions for a number of species we shall know the direction and the rate of change in these species at the present day—a knowledge which is the only legitimate basis for speculations as to their past history and future fate."

Jamaica and Scientific Federation.

The Institute of Jamaica has just issued its Annual Report for 1892-3. Under the late curatorship of Mr. T. D. A. Cockerell, the Museum seems to have advanced both in scientific importance and popular favour, although economic entomology has taken up much time that might otherwise have been devoted to collecting. The list of 32 specialists in various parts of the world to whom specimens were sent for identification occasions the following excellent remarks: "It is by means of this correspondence, and through publications, that the Institute becomes of international importance; and it is submitted that no museum can be efficient as a local exponent of scientific principles unless it is in this sense international. For this reason, although the Museum is supported by the people of Jamaica, it is felt that a naturalist in New Zealand or Japan is as much entitled to information or specimens (provided they are for the purpose of serious study) as a resident of this island. This principle is so well recognised among naturalists that assistance is asked of any specialist, with the full confidence that, if possible, it will be granted. To cite an example. The Institute has been continually indebted to the United States Department of Agriculture for all sorts of help, which has been given as freely as if Jamaica were United States territory."

How strong a contrast are these words to those which, on another page of the report, the Board feel compelled to use concerning the attitude of the people of Jamaica towards an institution that should be far more intimately connected with them! "The interest taken in the Imperial Institute in America is," they say, "of a very discouraging character." This is to be regretted, but also to be excused. What does a Jamaican arriving in London first learn of this

magnificent building and its extensive organisation? He sees on a newspaper placard:—

IMPERIAL INSTITUTE.
SMOKING CONCERTS.

Counsel's Opinion.

Horace Woollaston Monckton, F.L.S., F.G.S., of the Inner Temple, Barrister-at-Law, has kindly sent us a reprint of some "Short Papers," samples apparently drawn at hazard from the numerous compartments of a many-sided mind. Among articles so diversely interesting to the man of science as "Fish Culture at Howietown," "Legitimation," "Trial by Wager of Battle," and—but no, we dare not add "The Bagshot Beds of the London Basin"—there is one on a subject we have occasionally dealt with, "Women as Fellows of Scientific Societies." As a presentment of the question in its legal aspect, this paper may save many of our learned paupers the lawyer's fee that they could so ill spare. Mr. Monckton's opinion is that, assuming women were not mentioned in the original charter, and had not for some 60 years been admitted to a given Society, then, if it were wished to admit women, a new charter would be needed to make their election binding in law. The author's words are Delphic in obscurity and Scottish in caution:—"There is a new charter necessary—some may be of opinion that is—but this seems going rather far—suppose every fellow of the society wished to alter the usage, and there is nothing in the charter against the proposed alteration—a renewal of the charter seems somewhat superfluous. It has, we believe, been suggested by high authority, that a meeting of the fellows specially called for the purpose, may decide the question by a majority of those present, and perhaps that is a fairly practical view of the question. In any case we may perhaps say with safety that if a majority of a fairly representative meeting, after full notice, decided to alter the usage and admit women as fellows, the courts would be slow to interfere with such a decision."

The Growth of a Madrepore Coral.

Mr. G. C. Bourne has returned to his early love, and in the *Scientific Transactions of the Royal Dublin Society* (vol. v., pp. 205–238, pls. xxii.–xxv.) gives an exceedingly interesting account of those young stages in the development of the Madrepore coral *Fungia* that succeed the embryo-stage. The extreme difficulty of investigating organisms in which the soft body-tissues are so closely inter-penetrated by hard skeletal tissues, or stereom, is paralleled by the difficulty of describing the results in brief yet intelligible language, and the difficulty is not lessened by the use of the new terms that Mr. Bourne has found it advisable to invent. To only one point can we now direct attention. The large, flat coral, which has been called *Fungia*

from its likeness to the inverted head of a common mushroom, resembles, in its earliest fixed stage, the young of the ordinary cup coral, *Caryophyllia*. This cup-like form may remain solitary and gradually develop into the adult individual, or it may produce buds from its wall, which also develop into individuals and thus combine with the original individual to form a colony. In this way there is often produced a kind of stalk which carries many developing individuals. But after a time these latter become separated from the original stalk and set up for themselves, just as though Brussels sprouts were to fall off from the stalk on which they grew and to finish life as independent cabbages. Here is a difficulty: the various cups are joined to the stalk not only by soft living tissue but by solid, calcareous tissue or stereom; how, then, does this stereom become divided? Mr. Bourne finds that the coral is attacked, chiefly in this particular region, by various parasites, notably one of vegetable nature. The borings made by these and the limy matter deposited by them in place of the original stereom, render the junction opportunely brittle. It is, however, hardly likely that parasites should conduct their attacks solely for the convenience of their host, without some predisposing cause. Such a cause Mr. Bourne finds in the degeneration of the soft tissues in this region, and he infers that this degeneration of the soft tissues has some weakening effect on the stereom, whereby it is rendered more liable to the attacks of parasites. Similar changes are seen in shells removed from the influence of living tissue, but it is hard to learn the exact nature of the effect that the proximity of soft parts has on stereom. Mr. Bourne suggests "that the shell or coral is in some way affected by its contact with an osmotic surface, and that after separation a molecular change takes place, involving a re-arrangement of the crystalline structure." In the case of shells, however, it should be remembered that the calcite is deposited in organic membrane, which, it may be assumed, is more readily affected in this manner than would be the case if it were homogeneous as coral stereom is thought to be. It is possible that some such organic substratum may yet be discovered in the coral stereom, and this would render Mr. Bourne's explanation still more credible.

The vegetable parasite that proves so useful to *Fungia* is called by Mr. Bourne, *Achlya penetrans*. *Achlya*, however, is a genus of the Saprolegnaceæ, which are not known to live in the sea, and are in fact always destroyed by salt water. On the other hand, it has been shown that certain green algæ infest corals and marine shells in this manner, and we would suggest that the form described by Mr. Bourne is probably allied to the genus *Gomontia* of Bornet. It seems as though the botanists had kept their researches in this direction a little too much to themselves, and we hope to induce some authority on the subject to retail his knowledge in a future number of NATURAL SCIENCE.

Geology of New Zealand.

The Minister of Mines for New Zealand has recently issued his statement for 1892–3 (Wellington: 1893). The only portion of any scientific interest is an account by Mr. Alexander McKay of "Geological Explorations of the Northern part of Westland" (pp. 132–186). The country of Westland is on the west coast of the province of Canterbury, and includes the western slopes of the Southern Alps, and the lower grounds between the mountains and the sea from the Grey River to the northern boundary of Otago. The rocks exposed in the district, as shown on the geological map that accompanies the paper, are of very varied ages and character; they include Quaternary and Tertiary gravels, clays and sands, a whole series of Cretaceo-Tertiary limestones, sandstones, and marls, some diabasic ash-beds apparently of Triassic age, Carboniferous slates, slightly metamorphosed Devonian rocks, and other metamorphic and igneous rocks of which the age is uncertain.

While considering the disposition and origin of the auriferous gravels for the practical purpose of gold mining, Mr. McKay finds it necessary to investigate the former distribution of land in this portion of the South Island, and he concludes that all its great physical features are of Pliocene or post-Pliocene origin. He believes, indeed, "that a mighty mountain-range rose from the sea, possibly towering to heights far above the limits of eternal snow, since the Miocene period, and that its central and western parts were subsequently depressed, till the ocean removed or now rolls over its highest peaks." And he supposes that these changes took place as follows:—"During Tertiary times, up to the close of the marine deposits of the Miocene period, New Zealand was greatly depressed, and by far the greater part of its present area was below the level of the sea. At the period of greatest depression, Von Haast sketches us the South Island as consisting of a line of rock-islets formed by the outstanding higher peaks of the main range of mountains; but it is not clear that even these stood above the water-level. And if it be contended that a consideration of the fauna and flora of these islands at the present day, in comparison with what characterised former geological periods within the same area, necessitates the uninterrupted existence of land, it does not follow that this land must have been the crest of the Southern Alps. Such land may have lain to the westward of the present coast-line, but more probably it lay to the eastward in the line of the older axis of New Zealand, trending in a N.W. and S.E. direction. The N.E. and S.W. line of elevation is modern compared with this other, and probably was but feebly marked prior to the elevation at the close of the Miocene period."

In a previous report (1890–91, p. 1), Mr. McKay has dealt with the mode of appearance of the main chain and other mountain ranges of the northern and central parts of the South Island. "The manner in

which the Younger Miocene and Cretaceo-Tertiary strata are tilted and faulted so as to form nearly vertical strata in contact with the crystalline and older sedimentary rocks between Kanieri Lake and Hokitika River, and the manner in which the same, and even younger beds, are involved along the western base of Mt. Greenland, and at the same time appear on the top of the mountain and far below sea-level, within a horizontal distance of some four to five miles, shows conclusively that very great displacements have taken place." Further, he claims that the various lines of dislocation prove the subsidence of vast masses of land, which formerly extended westward of Hokitika, and constituted the western wing of the great anticlime, if not the central knot of the whole mountain system. And it was this now vanished land that provided the materials of the older auriferous gravels.

Would that theory and practice might always walk so amicably hand in hand! But not every mining geologist is a McKay.

"A NATURALIST'S NOTES OFF MULL."

IN *Good Words* for December last, there is an article with the above title by one who gives the name of "Nether Lochaber." The writer remarks that "As Saint Patrick is fabled to have banished all noxious reptiles from Ireland, so, according to Adamnan, did Saint Columna banish all noxious reptiles from Iona, and so, according to a very old tradition, did Saint Maluac from the island of Lismore. It is a curious enough fact, account for it as we may, that not only is the viper not found in Iona, but even if captured ever so gently and conveyed to the sacred isle hale and hearty, from the opposite shores of Mull, where it is common, it will instantly sicken and die."

He goes on to describe how "a friend of our own, a well-known artist," carefully imported into Iona a couple of vipers. They were captured with an angler's landing-net and conveyed without injury to the island; and as soon as they were released they twisted and wriggled about in a lively-enough fashion. The artist stated that "As I was lighting my pipe, however, and preparing to sit down on a knoll above them, so as the better to watch their movements, what was my surprise to see one of them suddenly stretch himself out as straight and stiff as an ellwand, and with a visible shiver and single gasp give up the ghost! In a few seconds the other adder followed suit—died precisely in the same manner as its companion; . . . . I am now persuaded that a viper will not live in Iona."

It would be interesting to know more of the circumstances under which these observations were made. They appear to have been characterised by scarcely sufficient scientific acumen and caution to warrant so broad a generalisation.

THE argument from fossils as to former climatic conditions, has often been recognised as exposed to many chances of error.

Another possible explanation of apparent tropical conditions is suggested by Dr. V. Ball in a paper on the folk-lore of the volcanoes and hot springs of India, published in the *Proceedings of the Royal Irish Academy* (ser. 3, vol. iii., pp. 151–169). No one who has travelled in volcanic districts, where hot springs are still active, can have failed to observe that they have considerable influence on the surrounding vegetation, and even, as has been pointed out by various writers, on the fauna, both aquatic and terrestrial. It is not only the lower animals, but also human beings, who, like the Maoris and the Japanese, flourish in the neighbourhood of hot springs where the purely climatic conditions would otherwise be too severe. Dr. Ball, then, writes as follows:

"Where the fossils of animals or plants are found which seem to indicate tropical or semi-tropical conditions of the climate at the time when they lived, may it not be possible to suggest, especially if there be any facts tending to prove the existence of different climatic conditions elsewhere at the same time, that there may have been widespread fumaroles or hot springs sufficient to have produced local hot-houses in which animals and plants may have flourished, which could not otherwise have existed in the normal conditions of climate belonging properly to the time and place?"

Under certain circumstances the explanation might be plausible; but we doubt whether such circumstances have as yet presented themselves to geologists. It must be remembered that such effects would be extremely local, and that thermal activity would probably leave other traces of its former existence in the shape of chemical deposits.

In the funnel of certain Cephalopods, several authors have noticed a peculiar cushion-like organ, situated a little behind the valve, and this has, for very insufficient reasons, been called "Verrill's organ" by Hoyle and others. Its function and homology have been the subject of some discussion. Ferussac and d'Orbigny confused it with a transverse muscle; H. Müller, in 1852, thought it was a stinging organ; Verrill, in 1882, considered it "the true homologue of the foot of gastropods"; Laurie, in 1888, from rather insufficient material, showed its glandular nature, and believed that it secreted mucus, but his observations were criticised by Brock; Hoyle, in 1889, believed that it served to close the funnel. That it is really a mucous gland is now proved by the careful observations of G. Jatta (*Boll. Soc. Nat. in Napoli*, vol. vii., p. 45, 1893), who has observed it in 32 species belonging to 21 genera, thus bringing the number of genera in which it has been found from 10 to 27. He describes and figures six main modifications of its arrangement, and gives excellent drawings to show its microscopic structure in different stages of its development. He concludes that this funnel organ is a mucous gland homologous with the pedal glands of other mollusca. If this

be so, the organ must be somewhat archaic, and one would expect to find it in *Nautilus*, where, to the best of our knowledge, it has never been described.

Among the more important new arrivals at the London Zoological Society's Gardens are two leopards which represent the extremes of colouration to be seen in the Leopard tribe; one of them is the black variety of the common leopard, the other the so-called Snow Leopard or Ounce. The latter animal, presented to the Society, is a valuable acquisition, for the Snow Leopard is a costly animal to buy, and it inhabits a limited tract of country; hence very few specimens have been on view in the Regent's Park.

Signor G. A. de Amicis has just published (*Boll. Soc. Geol. Ital.* 1893), "I foraminiferi del pliocene inferiore di Trinité-Victor (Nizzardo)," an important contribution to our knowledge of the Pliocene Foraminifera of Italy. One hundred and twenty-six forms are recorded, to each of which a very full and interesting synonymy is given, while only two forms are recorded as new, an evidence of the extreme care bestowed upon his work by the author, who has swept away many varietal forms recently described as new by other authors from imperfect acquaintance with the literature.

Students of cell-division will find an interesting article by E. Overton on the reduction in number of the chromosomes in the nucleus of plants, published in the *Vierteljahrschrift der Naturforschenden Gesellschaft in Zürich* (Jahrg. xxxviii., pp. 169–186, 1893).

The *American Journal of Science* for January contains a paper by Mr. S. P. Langley on "The Internal Work of the Wind." The subject is not physiological except so far as connected with what the author calls the science of Aerodromics, which is nothing more terrible than flying. In the same number E. H. Williams, jun., concludes that they have had but one Ice Age in North America, and that one both short and recent. C. D. Walcott has a note on Cambrian Rocks of Pennsylvania, and J. B. Woodworth, while discussing the erosive action of blown sand in New England, finds it necessary to coin the word "glyptolith" for a wind-carved rock surface. Old England sees no necessity for anything less intelligible than good old English.

The *Midland Naturalist* ended its career, as announced, with the December number, and *The Field Club* is now incorporated with *Nature Notes*. We are pleased to learn that *Science Gossip*, which ceased to appear last autumn, is shortly to be revived under the editorship of Mr. John T. Carrington, assisted by Mr. Edward Step.

I.

Neuter Insects and Lamarckism.

MR. HERBERT SPENCER, defending Lamarkian views of heredity against Professor Weismann,[1] has to maintain that the special structures and instincts of neuter insects were first developed in fertile ancestors. He is driven to this assumption, because he holds that complex evolution cannot occur without the aid of the inherited effects of use and disuse; and such use-inheritance is obviously excluded in the case of neuter bees, ants, and termites, which cannot transmit acquired characters to posterity. Of course, many of the instincts and structures of neuter insects—such as those needed for obtaining food, sheltering and feeding the larvæ, and so forth—were already present in the primitive queens or fertile females of unsocial and semi-social stages. But in many other cases—and it is these cases which more particularly demand our attention—it seems hardly conceivable that the instincts and structures could ever have been possessed by fertile ancestors. A few examples will illustrate the improbability of Mr. Spencer's assumption.

1. In some species of ants there is a caste of neuters possessing "an enormously developed abdomen which secretes a sort of honey, supplying the place of that excreted by the aphides, or the domestic cattle, as they may be called, which our European ants guard and imprison."[2] Their abdomen is so distended with this honey that they become almost unable to move. Is it credible that parents were thus unfitted for the work of multiplication by becoming living honey jars, or factories and storehouses for the general use of the community or family? Can we believe that queens or drones first evolved so remarkable an unfitness for their special functions, while still continuing the nuptial flights, and retaining the reproductive fertility which would be necessary for transmitting the effects of use and disuse to posterity?

2. In the warrior caste of neuters among the termites—and in this caste alone—the head and jaws are more than a third of the total length of their possessors, and are "almost as big as the rest of their bodies." These huge, heavy heads are carried with apparent

[1] "A Rejoinder to Professor Weismann." *Contemporary Review*, December, 1893.

[2] *Origin of Species*, p. 231.

difficulty. The fighting instincts are developed to a remarkable degree, while the capacity and inclination for ordinary work have been entirely lost. Is it probable that the parents of the race ever evolved the structures and instincts of the warrior in so pre-eminent a degree—thereby correspondingly unfitting themselves for more indispensable functions? If it be alleged that the soldier type was evolved among the males or drones, we must notice that the evolution of heavy heads and of blindness and winglessness would be inconsistent with fitness for the all-important wedding flight, so essential for the diffusion of the species and its preservation from the evils of continued close interbreeding. Such evolution could apparently only take place in proportion as male functions degenerated and disappeared—that is, only as the evolving warrior became a neuter.

3. Among sundry ants there are *three neuter castes*—such as workers, warriors, and living honey-pots, or workers, warriors, and "overseers"—and these are quite distinct in structure, functions, and instincts. Were *three* varieties of instinct and organisation present in the original male and female? Will it be suggested that there were double forms of males or females, or that the soldiers, workers, and honey-makers of *Myrmecocystus mexicanus* are mere gradations?

4. The instincts and the emotions, if we may so call them, of neuter bees centre round the queen in an astonishing manner. The evolution of these special instincts would easily *commence* in fertile daughters who helped the queen-mother at the cost of delay or neglect of their own maternal functions (a step towards the formation of a neuter caste), but could not have been thus completed in the various details of the final stages. Thus, if we allow that the fertile females or queens once loved their rivals as strongly as they now hate them, we cannot also suppose that they encouraged and compelled these rivals to fight till only one of them survived. Females could not imprison both their queen and themselves, nor release themselves only on special and suitable occasions—as is now done by the neuters. Mr. Spencer seeks to explain the "swarming" of bees as a kind of inherited reminiscence of the nuptial flight. But these neuters or workers are imperfectly developed females. If the massacre of the drones was first carried out by queens, whose murderous hatred is now directed solely against their own sex, are we also to believe that a nuptial pursuit of a *female* originated in fertile females whose frantic jealousy of rivals now leads them to pull down cells to destroy even their own daughters? The queen, part of whose sexual instincts the neuters are supposed to retain, does not pursue another bee—the drones pursue her. Are we to suppose that the imperfect females inherit the instinct of pursuit from the males? If swarming is really due to an inherited but perverted sexual instinct derived from either parent, why do the neuters carefully abstain from following their queen during the actual nuptial flight? Why do they only swarm—or take abortive nuptial flights, as we are to suppose—on quite a

different occasion, when the queen is sent forth from the hive and founds a fresh colony? And what could have thus usefully perverted or modified the sexual instinct to such different aims and ends except Natural Selection? Why need we suppose that this great ruling factor has entirely ceased to improve or evolve instincts and intelligence in neuter insects ever since the period, however remote, when the queens began to lose the all-important instincts and capacities which are now preserved only in the neuters?

5. The sterility of the neuters and its intimate association or correlation with the many important characteristics confined to these sterile insects, obviously cannot have been developed in females while they remained fertile. Such sterility, combined with such perfect development in other directions, must evidently have been evolved by the favoured survival of such queens as produced the most efficient communities. The infertility of neuters shows in the clearest possible manner that important potentialities may arise and become established in parental germ-plasm without ever being developed in the actual transmitters.

Besides the difficulty of accounting for complex upward evolution or enlargement of parts in neuters, Mr. Spencer has also to meet the converse difficulty of accounting for equally complex evolution in the direction of a co-ordinated reduction or diminution of parts and instincts. If, as he would have us believe, the one form of evolution is impossible in neuters, the other should be equally so. Mr. Spencer cannot call in panmixia, since he does not admit the reducing power of this factor, but he alleges defective nutrition as a leading cause of downward or degenerative evolution in various organs and instincts in neuters. But we must not confound a merely proximate means with the great over-ruling factor which has utilised and perfected such means as skilfully as man converted rude flints into efficient tools. How could mere quality or quantity of food have proved so wonderfully adaptive in its effects? How could stinted nutrition fit the neuters so exquisitely for their various tasks in all details, positive and negative alike? Must it not have been Natural Selection, rather than poor food, which maintained the health, strength, and efficiency of the poorly-fed neuters and their specially large brain and superior intelligence, and all such instincts and organs as are requisite for their tasks? Must not Natural Selection have been the controlling or guiding influence which so advantageously determined what useful modifications should flourish in connection with certain modifications of nutrition, and what useless organs or instincts should dwindle and disappear? In one species of ants there are two castes of workers, and, in addition to other remarkable differences, the workers in one of these castes are only a third as long as the other, and the head and jaws are reduced to a still greater extent; which is as if one set of women in a nation were sterilised and reduced to, say, three feet in height by ill-feeding while another class of women were reduced

by still poorer feeding to only one foot in height, their heads and jaws being diminished in still greater proportion. Yet these starvelings appear to be just as sound and healthy and as perfectly fitted in all details to their place in the social economy as the queens and males. Can we suppose that insufficient nutrition caused the neuters among termites and in various species of ants to become quite blind as well as wingless, while it had no such effect on the wings and eyesight of neuter bees and wasps? Will degree or quality of nutrition account for variations such as have turned two eyes into a single eye placed in the middle of the head, as happens in one caste, and in the one caste only, of certain ants? Of course, there will be some determining circumstance which decides what sex and caste each egg shall develop; and some of the varying susceptibilities of growing organisms to the influence of food might well be seized upon by Natural Selection, and might be intensified, corrected, and adaptively perfected.[3] But such an attainment of specialised fitness would be complex adaptation of instincts and organs in neuter insects by Natural Selection—a process which is hardly separable from the form of evolution which Mr. Spencer holds to be practically impossible.

If, as Mr. Spencer must assume, the workers, warriors, living honey-pots, and so forth, inherit their positive characteristics from fertile ancestors, in whom they were first developed, why has there been no similar transmission of the long-continued decay and disappearance of such capacities and structures in queens and drones? If the effects of use were transmitted, why are not the effects of disuse transmitted? If, in spite of underfeeding, the neuters, and the neuters alone, continue to inherit the former capacities of the richly-fed queen, why do they not inherit her present incompetence and inferiority? Surely underfeeding does not *strictly preserve* complicated instincts and massive organs which are no longer possessed or exercised by parents. It cannot be so discriminative or adaptive as this. Natural Selection has to be brought in as the only factor capable of thus counteracting the inherited effects of parental disuse. And if Natural Selection can effect complicated and discriminative preservation, why cannot it effect advance? If it can maintain innumerable structures of brain and body at a high level of efficiency in many essential points, in spite of the otherwise disastrous effects of parental disuse, why

[3] Mr. Spencer thinks that the sex of the drones is determined by the defective nourishment of the queen, whereas, in the case of bees, experimental observation shows that all unfertilised eggs yield drones, and that for a long time after fertilisation the queen appears to have the power of determining the sex of the eggs she lays—the female eggs developing, of course, into queens or neuters according to the food and treatment they receive. In the case of termites, Bates concludes that the soldiers and workers are distinct from the egg, and that the differences in these castes do not arise from any difference of food or treatment during their earlier stages. M. Lespès believes that he found imperfect males and females in each of these castes.

may it not in some cases raise the general level of efficiency, and so improve neuter insects independently of use-inheritance?

Those who hold that Natural Selection can preserve highly complicated efficiency by fully counteracting the lowering power of disuse (and underfeeding?) in innumerable co-ordinated points—and yet that it can do no more in the case of higher animals where no such opposition has to be overcome—must face the logical conclusion from their own premises, that the actual power of use-inheritance is precisely nothing—Natural Selection being exactly as powerful either with or without its opposition.

The cherished opinion that complex evolution is impossible without the aid of use-inheritance, is by no means widely accepted. Darwin and Wallace, co-discoverers of the principle of Natural Selection, have deliberately rejected the assumption. It seems, indeed, to be merely one of those artificial difficulties which philosophers in all ages have been wont to construct for themselves—much as Leibnitz convinced himself that the law of gravitation was impossible. The process of complex evolution may be compared to a series of competitive examinations, in which failure in any one of many subjects is fatal to success. Surely the standard of general efficiency must be raised by the rejection of the least efficient candidates. Otherwise, what is the use of competitive examinations? Selection, whether artificial or natural, cannot well be neutral in its effects. Evidently successful or selected candidates will display more than average capacity for carrying out the combined work exacted of them by the examiners. Surely a similar process in nature must similarly raise the level of the *minima* in all essential points or subjects without correspondingly preventing a raising of the *maxima*, which, of course, will often vary upwards, since organic variability is in all directions. Let us take another comparison. The strength of a chain is that of its weakest link. If chains with the weakest links are rejected, the chains that survive the test will manifestly be stronger than those that break. Rigorous elimination of weak links, without any correspondingly rigorous rejection of strong links, must improve the strength or fitness of the links in general, however numerous they may be. Organisms are such chains; and so long as defective links or *minima* are eliminated more often than superfluously strong links or *maxima*, the average of efficiency in all the links may well be a rising one. If defective parts are incessantly eliminated (together, of course, with the organisms which they ruin) Natural Selection may gradually raise the standard of efficiency in *all* the necessary co-operative parts or organs. Such a process cannot fairly be described as an oft-repeated "fortuitous concourse of variations"; for all that is needed is ordinary variations and their extinction, so far as they are hostile to general efficiency and success.

Mr. Spencer at one time represented the chances against complex evolution by Natural Selection as "infinity to one." He has since

more moderately put down the chances against a certain combination as "millions to one," and against a still more complex combination as "billions to one." But a million millions are but ten multiplied into itself eleven times. The selection or survival of one out of ten during only a dozen consecutive generations, is equivalent to the selection or survival of one out of a potential billion. The survival of one out of two for forty generations gives a similar result. Allowing for atavism and many other hindrances which will seriously retard the rate of evolution of complex efficiency, what objection can there be to the supposition of slow complex evolution by survival of the fittest during, not a dozen or forty generations, but a thousand or a million?

Mr. Spencer contrasts the facts that varieties of dogs cannot be produced by differences of nutrition, and that differences of nutrition are known to determine the caste in some of the social insects. He holds that this proves that, in the case of social insects, "the production of their various castes does not result from the Natural Selection of varying germ-plasm." But what else could have evolved the highly peculiar potentialities, or sets of potentialities, of a germ-plasm capable of developing not merely into either of two sexes (which is common to dogs and other animals), but into one, or two, or three additional neuter castes besides? The absence or non-evolution of special susceptibilities to the influence of nutrition in dogs is no disproof of their evolution by Natural Selection in bees and ants. On the contrary, it seems to show that a long process of evolution must have been required for their development in social insects. No such additional complexities and susceptibilities of the germ-plasm appear in mammals, where there have been no special means or steps by which Natural Selection would be likely to adequately favour and evolve them. They only appear in certain egg-laying organisms which feed their helpless larvæ to maturity, so that the chances of the evolution of neuter helpers in the exceptionally arduous maternal task are of a highly favourable character. Delay or loss of the reproductive portion of the maternal functions in some of the offspring, if combined with early appearance of the nursing instincts, would be an advantage in rearing a numerous family of younger sisters and brothers, and this would greatly promote the success of the queen and her fertile progeny. A dog could not be thus readily or materially assisted by her pups either in the growth of embryos within her, or in the suckling or feeding of the young after birth. She does not rear completely helpless offspring to complete maturity; her family breaks up at an early period. The evolution of mammals has been on different lines. They feed their offspring for a time, indeed, but by no means to maturity, as is necessary where the entire larval or caterpillar stage has to be provided for until the full-grown imago or perfect insect emerges. As neuter castes are *only* found where Natural Selection has had special opportunities or facilities for such evolution, we may

very properly infer that Natural Selection has been the determining cause of such evolution.

Neuter castes are confined to a few closely-related families of the social Hymenoptera, and to the termites, or "white ants," as they are popularly called. Seeing how exceptional the peculiarity of this complication is in nature, and yet how extensively it is diffused among the many species of these social insects, we may reasonably conclude that the peculiarity did not arise independently and separately in thousands of species of ants, bees, and wasps, even if it should have had a distinct origin in the case of the termites. Originating, as we may suppose, in exceedingly remote ages, and forming an advantageous basis or accompaniment of social forms of evolution, the peculiarity or susceptibility has been evolved and utilised to an extent which has allowed special scope for many important differences and complexities which otherwise could not have arisen. In some cases, as with some humble bees, comparatively solitary conditions, and widely-scattered nests or cells, may have aided or allowed survival, by the more effectual preservation of the honey and larvæ from marauding enemies. In such cases, Natural Selection may neglect or repress the social tendency and the intimately-related potentialities and instincts involved in the production of a neuter caste. Wasps, being carnivorous, and, therefore, unable to store and preserve food for the winter, have not evolved so thorough a division of labour and function as the hive-bees; for such solitary fertilised queens as survive the winter have to house and feed their first brood of neuters by their own efforts. Bees, ants, and termites commonly avoid this annual destruction of the community, their food being less perishable, so that stores can be laid up for times of scarcity. We find that intelligence, instinct, and special structures are most highly elaborated in the neuters of those species in which the queens and drones have most thoroughly lost such capacities or structures. The whole circumstances tend to show that Natural Selection has simultaneously effected increasing specialisation in neuters and queens alike in the direction of division of labour and the more perfect adaptation of each caste to its own particular functions in the community. The various neuter castes seem only to have been evolved in directions that have adequately aided the prosperity of the stirp; and the continued evolution or improvement of workers, warriors, and other neuters would promote the success of the stock quite independently of any similar development in queens or drones in whom it would be disadvantageous. There seems to be every reason for believing, with Darwin, that complex evolution *has* taken place in neuter insects, and that the case for the supposed necessity of use-inheritance in such evolution falls to the ground.

WM. PLATT BALL.

II.

Natural Science in Japan.

II.—PRESENT.

THE mere mention of the various institutions, in connection with which it will be convenient to describe the scientific development of modern Japan, is enough to show how enormous the advance of the last quarter of a century has been. They are The College of Science of the Imperial University at Tokio, the Geological Survey, the Imperial Museum at Ueno Park, the Learned Societies, and various other educational bodies that have for part of their task the dissemination of natural knowledge. In the above order they will now be considered.

The Imperial University, or Teikoku Daigaku, consists at the present day of the six Colleges of Law, Literature, Science, Medicine, Engineering and Agriculture. These Colleges have had very various origins, and their rather complicated history is detailed in the University Calendar (Z. P. Maruya & Co., Tokio). The Science College, with which we are chiefly concerned, sprang, together with the Colleges of Law and Literature, from an institution of some antiquity founded by the late Tokugawa dynasty and revived by the present Imperial Government after the Restoration of 1868. Up to 1885 the College of Science undertook instruction in many practical and technical subjects; but in that year a Department of Technology was created, to which the courses in Engineering, Mining, Applied Chemistry, Naval Architecture and kindred subjects were transferred. Since then the College has devoted its entire attention to the pure sciences, without too curiously considering whether they were "required for the purposes of the State," as demanded by Article I. of the Imperial Ordinance.

In this College of Science there have been established seven courses of instruction, or what we should call Schools, each of which extends over three years. They are in Mathematics, Astronomy, Physics, Chemistry, Zoology, Botany and Geology; but the last three alone concern us now. Neither of these three courses offers any definite instruction in either Physics or Chemistry, such as would be the case at an English University. But since a student who seeks admission to any College has to produce a certificate from one of the Higher Middle Schools, or to pass an equivalent examination, it is probable

that this very necessary training has been already supplied. In other respects each course is admirably broad, and affords a good grounding for each subsequent specialisation required of those who pass to a doctor's degree. This will be seen from the following sketch of the work done by a student in Zoology. During his first year he attends lectures on General Zoology, on Botany and on Geology, he does practical work in the Zoological and Botanical Laboratories, studies Physiological Chemistry with Laboratory work and learns how to determine Rocks and Minerals. In his second year he attends lectures on Botany, the Comparative Anatomy of Vertebrate animals, Histology, Embryology, Physiology and Palæontology. He does practical work in Botany, Histology and Embryology, and spends a few weeks at the Marine Laboratory. The third year is mainly devoted to work in the Zoological Laboratory, with two afternoons a week in the Bacteriological Laboratory during the third term. The student may also study Palæontology and certain special subjects. The work for a Botanical student is the same during the first two years; but in the third year the Botanical Laboratory is substituted for the Zoological, and a Botanical Colloquium takes the place of the special subjects of the Zoologist. In the same way the Geological student has lectures and practical work in Zoology and Botany, besides those more directly connected with his special subject.

At the end of these courses an examination is held, the passing of which makes the student a graduate of the University, but does not of itself entitle him at any time to the higher degrees. A graduate who desires to proceed to the degree of Doctor, which in the case of Natural Science is called *Rigaku-hakushi*, must attach himself to what is called the University Hall for a period of five years. During the two years immediately following his admission he must pursue a post-graduate course, which consists for the most part of special work either in the laboratory or the field. In the latter case his travelling expenses are defrayed by the College according to a fixed rate. After these two years he is free to devote himself to some special subject and to prepare the thesis that he is bound to present on applying for his doctorate.

This system of specialised practical and field-work, both in close connection with the University, is an admirable one. By its means, in the first place, a set of men are forwarded to the Geological Survey and similar scientific posts already thoroughly trained for their work; secondly, the collections of the University are increased and what is of more importance thoroughly worked out; while, lastly, any papers that may be published by these students pass directly under the eyes of the professors, and therefore do not manifest that inexperience in the art of description and exposition which too often mars the work of our own younger writers and which I have suffered from too much myself not to sympathise with in others.

The teaching organisation of the College of Science is, like that of all the others, very complete. In the subjects with which we are concerned the professors and lecturers are as follow,—in Zoology, Professors Kakichi Mitsukuri and Isao Ijima; in Botany, Professor Jinzō Matsumura and Assistant-Professor Saburō Ōkubo; in Geology, Professor Bunjirō Kotō and Assistant-Professor Yasushi Kikuchi; in Palæontology, Professor Matajirō Yokoyama; and in Seismology, Lecturer Fusakichi Ōmori. Physiology may appear a curious omission, but this is amply provided for in the College of Medicine.

The chief buildings of the University, including the offices, the Library, the Colleges of Law, Medicine, Engineering, Literature and Science, the First Hospital of the College of Medicine and the Dormitories of the Colleges, are situated in somewhat park-like grounds in the north of Tokio, which formerly belonged to the great Daimyo, or Lord, of Kaga. The buildings connected with the Natural Science Schools contain admirable laboratories, workrooms and museums, through which I was shown, with great kindness, by Professors Mitsukuri and Ijima.

The Museums that now concern us are two: the Zoological, and the Geological.

The Zoological Museum, which is under the direction of Professor Mitsukuri, is contained in one large room on the first floor. It contains not only specimens, dissections and models, intended for the instruction of the students, but also valuable collections of types described by graduates and professors, and a large amount of material from the lands and seas of Japan, that will be placed, as occasion offers, in the hands of those students who wish to take up some original investigation for the purpose of obtaining their doctorate. Hitherto many of the groups constituting the Japanese fauna have been worked out by Europeans; but it is hoped that in future this will be accomplished by the Japanese themselves. Among the noticeable collections in this room is one of the parasitic worms of Japan, which contains the types of Ijima and the specimens of *Tristomum* now being described by Goto. Here is exhibited a specimen of considerable human interest, namely a fine *Bothriocephalus latus*. This tape-worm was well-known to exist in Japan, and indeed caused great trouble in many districts; but its source could not be ascertained. At last Professor Ijima thought he had traced it to a fish called *Masu;* but the only way in which he could prove that the parasite infesting that fish was indeed the larva of *Bothriocephalus*, was by swallowing it. The experiment was successful. Twenty-two days afterwards the full-grown worm was obtained, and it now graces the shelves in the Museum of that University of which its erstwhile host is still a living ornament. Another fine collection is that of the Japanese birds, which is very complete and contains the types of Ijima and Stejneger. The collection of fish is also unusually good, a fact which is easily accounted for by the very various kinds of fish

that serve the Japanese as food. A walk through the Tokio fish-market about four o'clock in the morning reveals a wonderland to the eyes of the naturalist. Every possible and impossible variety of fish, flapping and twisting and twining in shallow tubs; sharks and threshers, waiting to be cut up into steaks or pounded into a kind of pemmican ; large octopods and cuttlefish angrily writhing in buckets and vainly changing their colours; shell-fish of every shape and hue, but chiefly *Arca* and the beautiful *Haliotis*. Nothing seems to be thrown away, and the consequence is that many rarities are secured for the University, while ordinary dissecting material may be had almost for the asking. Before leaving the Zoological Museum, we must notice some admirable anatomical models by Matsutaro Kikuchi, especially those representing the blood-vascular system of *Bufo japonica* and the blood-vascular and nervous systems of *Palinurus japonicus*. In such work as this the handiness and extreme delicacy of the Japanese are seen to the best advantage.

The Geological Museum is in a large T-shaped room on the ground floor. It has been arranged by the Geologist Koto, the Mineralogist Kikuchi and the Palæontologist Yokoyama. The minerals are arranged in two distinct sets; one to illustrate their physical properties, the other according to their chemical composition. Accompanying them is a catalogue, written in English. As in the British Museum, the general collection of fossils is arranged in zoological order, while the specimens found in the country itself are kept separate. These latter include the types of von Mojsisovics, who has described so many of the Triassic fossils of Japan, and the types of Yokoyama. Owing to the volcanic nature of the Japanese islands, such fossils as do occur are for the most part in a very altered condition, and are neither numerous nor well-preserved enough to be advantageously arranged according to a zoological classification; they are therefore disposed stratigraphically and according to their localities. The Museum also contains a general series of rocks. Besides the specimens of rocks and fossils at present exhibited, there are a large number that have been collected by students and are still kept in boxes downstairs awaiting identification. To judge from the state in which most of the fossils unfortunately occur, this will prove a difficult matter.

Connected with the Science College are the four following institutions, the Astronomical Observatory, the Seismological Observatory, the Botanic Garden and the Marine Biological Station.

The Seismological Observatory is the head-quarters of this branch of science for the whole world, and to this position it has been brought by the labours of Professors J. A. Ewing and John Milne. The instruments designed here and the results obtained by them are so well-known from the publications of those gentlemen and of Seikei Sekiya, the Professor of Seismology, that it is unnecessary to allude to them further in this place. It is enough to mention that the

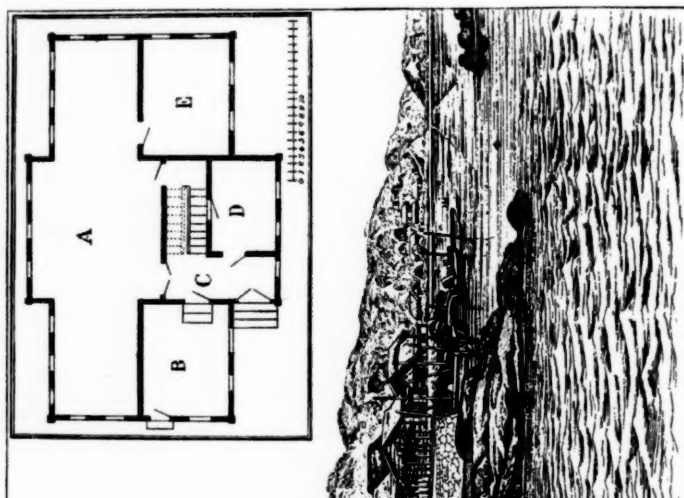


Fig. 1.—THE MARINE BIOLOGICAL STATION AT MISAKI, IN 1887.

investigations have already proved of great practical value, that the Observatory is open for consultation on all matters pertaining to earthquakes, and that the students of geology and other branches of science attend lectures from the professor and his assistant.

The Botanic Garden lies in a pleasant part of Tokio, about a mile from the University. It contains over three thousand species of plants, both native and foreign, which, in the main division of the garden, are distributed according to Bentham and Hooker's classification, as given in their *Genera Plantarum*. There are, however, minor divisions, such as a collection of medicinal plants, those plants that grow in shady places, various rare plants in pots, and a green-house with tropical plants. Besides plant-houses in various Japanese styles, there is also a pleasure garden with a building well suited for the social gatherings of scientific and other societies. How much pleasanter it would be for our learned societies to picnic at the Pagoda in Kew Gardens on a summer Sunday, instead of undergoing the boredom of a badly-served dinner in a London restaurant! From the garden, plants are daily sent to the University for the use of students, and on the other hand the students of Botany and Entomology spend a portion of their time in the garden. The Botanic Garden possesses a herbarium of considerable size, though not so complete as that belonging to the Botanic Institute of the Science College, which contains about 4,000 species of Japanese plants. Both the Garden and the Institute are always ready to exchange duplicates with foreign botanists, and the Botanic Garden is also ready to exchange seeds.

The Marine Biological Station is situated at Misaki, a small fishing-village at the end of the promontory that separates the bay of Sagami from that of Tokio. Opposite the village is an island, forming a sheltered strait over two square miles in extent and about eight fathoms in the deepest place. The laboratory, which was opened in 1887, is on the seashore fronting this strait (Fig. 1). The building is of wood, and one story high, except in the middle where it is two stories. The whole sea-front of the ground floor is occupied by the main laboratory (A), which is 48 feet long, 12 feet wide at the two ends and 18 feet in the middle, and is able to accommodate about ten workers. This room is fitted with small aquaria for the use of investigators. At the back of the main laboratory are a store-room (C), a library (E), and a room (B) with a cement floor for sorting out and preserving the specimens as they are brought in from the sea. From a tank outside the building, sea-water is conveyed into this last room and into the main laboratory. The first floor, over the middle of the building, is devoted to sleeping accommodation.

The situation of Misaki, between two bays and sheltered by the island Jōgashima, is extremely favourable to marine life. The strait itself, the neighbouring inlets, and the tide-pools on the ocean side of Jōgashima, furnish all kinds of bottom, while further

out at sea there are beds from which the fishermen dredge up the beautiful glass-rope sponge *Hyalonema* and a magnificent Pentacrinid, the *Metacrinus rotundus* of P. H. Carpenter. According to Professor Mitsukuri (*Journ. Coll. Sci.*, vol. i., p. 383, Tokio, 1887) the following are the more important animals found in this locality. "Foraminifera are likely to furnish a great many species. . . . Of the Radiolarians we have seen some—mostly of the Acanthometridæ. Sponges are well represented. . . . Specimens of *Hyalonema* in museums of Europe and America are in reality mostly from Misaki, although they are marked as from Enoshima where they are bought and sold . . . *Tetilla japonica*, Lampe, is found in great abundance in the harbour of Misaki during the summer months. Of the Coelenterata, hydroid colonies are not very numerous, although we found one species of *Aglaophenia* in great abundance in December. Hydromedusæ, Acalephæ, and Sea-anemones are fairly numerous. Corals are found living, as also *Veretillum* and other Pennatulids. Of the Echinoderms, there are several species of sea-urchins, star-fishes, ophiurans and holothurians, some species being found in great number. A *Comatula* is also found. . . . The Mollusca are exceptionally abundant. Tide-pools etc. may be said to be alive with them in the spring, and their egg-masses form conspicuous objects at the same season of the year. Some of the more noticeable molluscs are *Chiton*, *Haliotis*, *Aplysia*, a curious *Tethys* and other beautifully coloured Nudibranchs, *Patella*, etc. Cephalopoda are caught in abundance by fishermen. Crustaceans are very largely, and worms fairly well, represented. *Lingula* is found here as in almost every part of Japan. The inlet of Muroiso is fairly choked with Ascidians, and their bright red egg-masses form striking objects at the breeding season. Surface collection also furnishes many interesting animals. Besides the usual number of the Crustacean larvæ etc. we have caught *Doliolum*, *Salpa*, Pteropoda, Heteropoda (*Atlanta*, *Pterotrachea*), *Actinotrocha*, *Tornaria*, Siphonophora, *Pilidium*, Loven's larva etc. *Physalia* and *Charybdea* are also found. The Kuroshio [" black tide," a warm current] which passes off the coast of Japan has no doubt some influence on the surface fauna of this part."

How such a description must make the mouths of our Plymouth brethren water! And it must also be remembered that these splendid opportunities are not merely open to advanced investigators, but that all students in the biological school of the University are required to pass at least one term at this station. This seems a feature in which we might very well learn something from Japan.

Now that we know something about the organisation of the College of Science, we have to consider what has resulted from all this. In 1893 the number of students said to be working at the natural sciences was about thirty. There were, as is usual in other places, a larger number studying physics and chemistry. How many of these graduated, I was of course unable to learn at the time I was

in Tokio. In 1891, however, the graduates numbered one each in Physics, Mathematics, Zoology and Botany; and in 1892 they were one each in Mathematics and Astronomy, two in Physics, and one each in Chemistry, Zoology, Botany and Geology, making eight in all. These numbers are, perhaps, not large; at the same time they do not compare unfavourably with those of our old-established English Universities. Nor should we forget that the more practical Colleges of Medicine, Engineering and Agriculture, offering as they do more lucrative prospects, naturally draw many students away from pure science.

The researches carried out in the University laboratories have of late years been published in *The Journal of the College of Science, Imperial University, Japan*, 4to, Tokio. This was started in 1886, as a continuation of the scientific memoirs which had from time to time been published by the Tokio University, and as the channel through which the world at large might receive Japan's own contributions to the progress of science. The languages permitted in this publication are English, German and French; but so far, out of 71 papers, only 5 have been written in German and none in French. This is a contrast to the publications of the College of Medicine, which are entirely in German. Of this periodical a yearly volume is issued, containing about 368 pages and 30 plates in which the artistic patience and enthusiasm of the Japanese are beautifully displayed. In the earlier numbers of the Journal papers on physical and chemical subjects preponderated; but of late there has been a welcome increase of zoological papers. As writers of such we find the names of Goto, Hatta, Ijima, Inaba, Ishikawa, Kishinouye, Mitsukuri, Oka, Sasaki and Watase. In botany there are Miyoshi, Tanaka and Okubo; geological contributions are furnished by Kikuchi, Koto and Sekiya, while Yokoyama is at present the sole palæontologist. For me to express any opinion on the memoirs contained in these volumes would be presumption; enough to say that, in the words of the University Calendar, "they have been highly spoken of by various scientific journals of Europe and America, and many learned societies and institutions have expressed their desire for exchange," a desire, it may be added, which the Japanese are most willing to gratify. Of work done by Japanese but published in foreign journals, the names of Ito (Tokutaro), Iwakawa, Oka (Arajiro), Namiye, and Tsuboi, in addition to others already alluded to, are sufficient evidence, and it may be mentioned that, as its assistant professor of Zoology, the new University of Chicago has chosen Mr. S. Watase.

We pass now to consider the position of Geology in Japan, as exemplified chiefly by the Imperial Geological Survey.

The first portion of Japan to be examined geologically was the region known as Hokkaido, which includes what we Europeans call

Yezo and the Kuriles. In 1862, the Americans P. Blake and R. Pumpelly, who were engaged by the Tokugawa Government, made some observations in the southern part of Yezo; while from 1873 to 1875 various surveys were made under the superintendence of B. S. Lyman. Work was then suspended for thirteen years, till in 1888 Mr. K. Jimbō was appointed Chief Geologist of the Hokkaido and carried on the survey for the local authorities independently of the Imperial Survey, but in accordance with its methods.

Of Japan proper, the first geological survey was undertaken in 1878, by Mr. T. Wada, under the Geographical Bureau. In May 1879, the Imperial Geological Survey was established in accordance with the plans of Dr. Edmund Naumann, then Professor of Geology in the University, who was appointed its head. After some changes, the Survey finally assumed the title of "Chishitsu-chō-sajo," or Geological Survey Institute, T. Wada was appointed Director and E. Naumann Chief Geologist. In 1885 Dr. T. Harada succeeded Dr. E. Naumann, as inspector of both geological and topographical surveys, while the chemical laboratory was transferred from the direction of Mr. O. Korschelt to that of Mr. J. Takayama. At present the only foreigner on the staff is Dr. Max Fesca, the adviser of the agronomical survey.

The work of the Survey is distributed among four Sections,—Topographical, Geological, Agronomical and Chemical.

The Topographical Section makes and publishes maps upon which the geological features may subsequently be laid down. The original survey is done on the scale of 1 : 50,000, and in the office these sheets are reduced to the various scales required for the published maps. Simple topographical maps are published, both in Japanese and English, on the scales of 1 : 200,000 and 1 : 400,000, and each is constructed after the modified Flamsteed's projection, with the middle meridian 136° E. of Greenwich and the middle parallel 36° N. Of these maps, the large scale have contour-lines at distances of 40 metres, and the small scale at distances of 100 metres. Naturally the work of this Section has to be a stage ahead of that of the Geological. In the summer of last year, out of 97 sheets, the surveys of 53 had been finished, 29 sheets had been issued and 6 were in course of preparation.

The Geological Section makes a systematic geological examination of the whole country, with special regard to economic requirements. The surveyor examines the geological deposits and their structure within the region to which he has been appointed, and collects specimens of rocks, minerals and fossils from that region. He makes sketches of the routes he has traversed on the scale of 1 : 500,000, and puts on them detailed geological information, as well as the position of available economic materials. He also sketches profiles and sections, whether artificial or natural. On the return of the geologist to the office, the specimens that he has collected are

determined by the palæontologists and by the Chemical Section, and he himself sets to work to construct a geological map of the surveyed region on the scale of 1 : 100,000, with the help of the maps already prepared by the Topographical Section. He also constructs horizontal sections on either a true or an exaggerated scale. The published geological maps are on two scales, the same as those of the topographical maps. On them the geological formations are shown by different colours, while the positions of marked varieties of special economic substances are represented by conventional signs. Accompanying each map is an explanatory text, which is written in three chapters, the first dealing with the topographical features, the second describing the geological formations, and the last treating of the economic products; and this text is often illustrated by many profiles, sections and maps. There are also published, in conjunction with the other Sections, bulletins, which contain the results of investigations conducted by the Survey. All these are written in Japanese. Up to the beginning of last year 37 sheets out of 97 had been geologically surveyed, and twenty-six sheets had been issued of which all but three were accompanied by explanatory texts; 11 more sheets were in preparation. Of the five maps of the small scale or Reconnaissance survey, three had been published and two were in preparation.

Besides this regular series of maps, detailed surveys have been made of coal fields, oil lands and various mines; of the raw materials of various porcelains; of the sources of water supply for the towns of Tokio, Sakai and Kumamoto; of the geological structure of the Bay of Tokio, with a view to the formation of a harbour; of certain districts shaken or destroyed by landslips or earthquakes; and lastly of the region devastated by the violent eruption of Bandaisan in 1888. The bulletins explanatory of these are, like the preceding ones, in Japanese. Foreigners, therefore, who wish to learn something of Japanese Geology must refer to Dr. E. Naumann's paper "Ueber den Bau und die Entstehung der japanischen Inseln," two papers by Dr. T. Harada, "Versuch einer geotektonischen Gliederung der japanischen Inseln" and "Die japanischen Inseln," and the Explanatory Text and Geological Sketch of Hokkaido by K. Jimbō, which are both in English. Besides these official publications, the student may refer to papers by J. C. H. Godfrey (*Quart. Journ. Geol. Soc.*, xxxiv. p. 542, 1878), C. Gottsche (*Science*, i. p. 166, 1883), R. von Drasche (*Neues Jahrb. für Mineral.* 1879, pt. i., p. 41), D. Brauns (*Memoirs Science Dept., Tokio*, no. 4, 1881), H. van Chappelle (*Tijdschr. Nederl. aardrijkskundig Genootsch.*, iii. p. 436, 1886), H. B. Guppy (*Journ. N. China Branch Roy. Asiatic Soc.* [2] xvii. p. 25, 1882). It is to be hoped that some day the valuable observations buried in the Survey bulletins will be rendered more accessible, and this will be the case if, as the *American Geologist* informs us, they are eventually to be translated into German and English.

When the Geological Section has done its work, it is succeeded by the Agronomical, whose province it is to construct maps showing the various soils, to examine those soils with the view of discovering means by which their fertility may be preserved or improved, and, more especially, to survey those portions of the Empire that are not yet under cultivation, to see how far they are capable of it, and to investigate the quality, abundance and accessibility of the various mineral manures. Although not unknown in other European countries more advanced than ourselves, and although the British government geologists have of late begun to publish maps showing the surface geology, still we have but a small idea of a survey so thoroughly scientific in its working, so eminently practical in its application and so completely fulfilling those promises that were held out to the public when our own Geological Survey and Museum of Practical Geology were first started. For these reasons, an account of the Japanese Agronomical Survey, more detailed than has been given of the other Sections, may be of value as well as interest.

It is recognised that the nature of the solid rocks of any country has directly but a slight effect on its agricultural conditions; and this is especially the case in districts where there is a large amount of alluvium or of drift. On the contrary it is the *soils*, that is the weathered products of the solid rocks, often far removed from the original rock, that have most influence on the fertility of the land. The main object of the agronomical survey in its relation to geology is, therefore, to divide the soils derived from the different kinds of rocks into as many types as possible, and to judge the relative capabilities of those soils for cultivation. Hence the survey is not confined to the cultivated land, but is extended to regions that appear capable of cultivation and also to the forest ground.

First comes the field-work. On the maps already prepared by the Geological Section, on a scale of 1:500,000, the surveyor sketches the distribution of the various soils. He notes the relations of the soils to their mother rocks at different stages of weathering, and collects typical samples of both. The following notes are also made:—the mode of origin and the petrographical character of the soil; the nature of the subsoil, illustrated by sections and borings, to a depth, if possible, of three metres; the height of the land above sea-level; the configuration of the land; the underground water level; local climatic conditions; the registered value of the land; the conditions, methods and results of the farming actually carried on, with particulars as to rotation of crops, manures and similar agricultural details.

The samples of soils collected are next investigated in the laboratory, to find their mechanical composition, chemical constitution, physical properties and absorptive power. To determine its mechanical composition, each sample is quantitatively separated into thirteen parts according to the size of the grains, thus:—

1.	Size of grain larger than 10 mm. in diameter.		Gravels.
2.	,, between 10 & 8 ,,		
3.	,, ,, 8 & 6 ,,		
4.	,, ,, 6 & 4 ,,		
5.	,, ,, 4 & 3 ,,		Fine soil.
6.	,, ,, 3 & 2 ,,		
7.	,, ,, 2 & 1 ,,		
8.	,, ,, 1 & ·5 ,,	Fine-earthy part.	
9.	,, ,, ·5 & ·25 ,,		
10.	,, ,, ·25 & ·1 ,,		
11.	,, ,, ·1 & ·05 ,,		
12.	,, ,, ·05 & ·01 ,,		
13.	,, smaller than ·01 ,,		

A sample of soil is first passed through a sieve with meshes 4 mm. in diameter, and the fine soil thus separated is mechanically analysed by Schöne's apparatus, by which the soil particles from 11 to 13 are washed out one after another with the respective pressures of ·2 mm., 2 mm. and 7 mm. velocity per second. The soil remaining in the cylinder of the apparatus is then separated by a set of sieves which have meshes with the respective diameters of 3, 2, 1, ·5 and ·25 m m.

For the chemical analysis a sample of soil is treated with concentrated hydrochloric acid, having a specific gravity of 1·2, by which the available constituents of soil can be well detected. The fine-earthy part of the soil is boiled in the acid for an hour and, after passing through the usual operation, an extract is made from which Alumina, the Iron oxides, Manganic oxide, Lime, Potash, Magnesia, Soda, Phosphoric acid, Sulphuric acid and Silica (soluble in hydrochloric acid and sodium carbonate) are successively determined Iron in the ferrous state is estimated by the "copper method" (Fesca, *Journ. für Landwirthschaft*, 1884, pp. 407–421) and, for a soil rich in humus, Carbon and Nitrogen are estimated, and in some cases Chlorine is determined. In order to examine the character of clay and its contents in the soil, the insoluble residue left after treating the soil with hydrochloric acid is fluxed with sulphuric acid, and the quantities of Alumina and Silica contained in it are then estimated.

The systematic examination of the physical properties of soil is fully described in Dr. Fesca's "Abhandlungen und Erlaüterungen zur agronomische Karte Provinz Kai," pp. 3–19. Briefly, the weight and permeability have to be noticed. The volume- or absolute weight and the specific gravity of the soil are estimated; and as the volume-weight of the soil varies directly as its porosity, the weight of each sample of soil is thus ascertained either in a loose or a compact state. The permeability of the soil to air and water is examined by ascertaining the water capacity and air contents of the soil, and by observing its imbibing and capillary powers during the process of experimenting.

To answer well the practical questions on manuring, the absorption of phosphoric acid and nitrogen in the soil must be examined. This is effected in the ordinary way, by means of the "bottle method,' using as absorbents monocalcium phosphate and sal ammoniac. However the use of the above absorbents has recently been found unsatisfactory, and at present ammonium phosphate is employed, although its exact standard has not yet been absolutely determined.

The maps published by the Agronomical Section are based upon those already prepared by the topographers, on a scale of 1 : 100,000.

Instead, however, of being separated into squares, as are the ordinary geological maps, they follow the lines of provincial and prefectural boundaries. On these maps the geological formations are represented by the usual colours, while the characters of the soils, classified according to physical conditions, are shown by inclined lines of different colours or crowded spots of various sizes in darker colours. Sections of the subsoil are delineated on one side of the map, and the spots where they were observed are denoted on the map by corresponding Roman numerals. In the summer of last year 27 prefectures had been surveyed and the maps of 12 published, as shown in the above figure.

With these maps explanatory texts are published, each divided into three chapters. The first describes the topographical features of the district, with special attention to the situation of the agricultural land and its transport facilities. The second contains a general view of the agricultural land with respect to its geological formations, and a detailed account of the soils investigated in the laboratory and of special mineral fertilisers. The third discusses the soils as factors in agriculture and their relations to plant growth, and compares the fertility of soils arising from the different geological formations.

Besides the regular work of the Section, the relations of the principal agricultural products to some of the more important local conditions have been studied in various parts of the Empire, and the results of this work have been embodied in "Beiträge zur Kenntniss der japanischen Landwirthschaft" and "Ueber die landwirthschaftlichen Verhältnisse Japan's und die Kolonization Hokkaido's etc."

The various analyses required by the Agronomical Section are carried out in its own laboratory. The Chemical Section therefore is chiefly occupied in analysing the minerals and rocks and in assaying the ores collected by the Geological Section. Analyses and tests are also conducted, according to a fixed tariff, for the benefit of the public, and materials of technical importance, such as potter's clay, kaolin, lubricating oil, cement and building stone, are examined. Besides the results published in the ordinary bulletins, this Section has issued special reports on Japanese fireclays, coals, limestones, cements, indigoes, lacquer and lubricating oils.

The staff employed in carrying out the multifarious operations of the Geological Survey is constituted as follows:—exclusive of the director and of the adviser of the Agronomical Section, 4 Topographers, 6 Geologists, 10 Agronomists and 9 Chemists. Besides these there are 10 Cartographers and many subordinate assistants. The time allotted for field work during each year is four months, during which time it is reckoned that a single geologist can survey one sheet, and a single agronomist half the area of a prefecture. Among others of the staff to whom I had the honour of being presented, my thanks are especially due to Mr. Kochibé, the learned chief of the Geological Section, for much courteous help in my enquiries and travels.

Connected with the Geological Survey are two Museums. The one, intended for the private use of the staff and for constant reference, is in a large room at the office of the survey. A more elaborate collection is displayed, for public instruction, at the head office of the Department of Agriculture, and corresponds, at least in intention, to our own Museum of Practical Geology. The geological collections of more purely scientific interest are contained either in the museum of the College of Science, which has already been described, or in the geological department of the institution which we have next to consider.

F. A. Bather.

(*To be continued.*)

III.

The Influence of Volcanic Dykes upon Littoral Life and Scenery.

ALONG the coast of Jersey there stretch for miles great masses of rocky, weed-grown reefs, laid bare with every tide; reefs cut and hewn into every imaginable form; channelled, and divided and sub-divided by numerous broad, artificial-looking roadways, and by interminable, intricate, mazy runnels.

If we examine these, calling to our assistance pick, and shovel, and geological hammer, we find all these paths and bye-paths to be the outward and visible signs of the presence of volcanic dykes that everywhere, in this fire-visited island, intersect and pierce the mother rock. The latter may be diorite, syenite, or schist; all are treated alike, and the resultant features closely approximate. As a rule, the dyke material is diabase, but minette (micaceous porphyry) is not uncommon. This filling, sometimes softer, and always more joint-riven, is much more rapidly disintegrated than the surrounding rock. Exposed to a violent tide—rising sometimes fully 42 feet—and to a sea occasionally very stormy, the disintegrated matter is quickly removed, and a ditch, often extremely well marked, is formed. This may vary in breadth from a few inches up to twenty yards, or even more.

The faunal features of these wave-worn dykes vary considerably, consequent upon whether their direction is at right angles to, or is parallel with, the coast. The former are poor in life, barren, and often sand-choked, but of great value to the agricultural community as cart tracks in the wracking season—that harvest time on the shore, when every farmyard in the island sends out all hands and carts to levy toll from the bleak rock-reefs of their abundant weedy crop. Many of the more marked of the eaten-out dykes serve this purpose, and it is difficult indeed for those who know only shores with a narrow littoral, to appreciate the vast importance of these natural cartways on a coast such as that of Jersey, where a distance of from one-and-a-half to two miles frequently separates high-water mark from the Laminarian zone, whose weedy growth is more greatly prized by farmers than the higher growing and commoner fucus.

Besides thus serving as ready-made roads to the far-distant lower

margin of the littoral, these dykes, piercing at their shore-end deep into the land, form natural passes on to the beach. Used from time immemorial, they now form the slip-ways or slips found in every parish in the island, and upon which the various parish assemblies have spent really considerable sums in improvement. I have examined a great number, and fully 75 per cent. of these slips mark the presence of an intrusive dyke running outwards to the sea.

Why these should be barren of life is easy of explanation. Their trend exposes them directly to the full fury of in-shore gales, which alternately with off-shore winds play a continual see-saw of removing and bringing back the surface layers of sand and shingle along the course of the dyke. Stability of environment, so necessary to the slow-spreading forms of littoral life, is wholly wanting.

In other cases, these dykes serve as determinants in the formation of many of the prettiest of the innumerable bays that line the coast. The great majority of such are small; sometimes independent inlets, but more generally secondary indents that go to make up the larger bays. In each the dyke originally formed a point of weakness, whereon the waves constantly pounding, first tore out a narrow pathway the width of the dyke-filling, and then, when the waves worked with greater force confined between the walls of this channel, the breach was gradually widened by the undermining and wrenching out of blocks of the mother rock. Given the initial weakness of the kind provided by such a dyke, it is difficult to set limits to the destroying, bay-making force of the waves acting continuously during a long lapse of time.

That this necessary time-factor has been present in Jersey, I am well convinced from many personal observations. At several points along the shore and high above the present sea-level I have traced unmistakable raised beaches composed principally of beds of loose, well-rounded pebbles (L'Etacq and along the North coast). I can also testify to *high-lying* sands and gravels, in some cases to be seen even resting upon the old beach pebbles. These sands, I feel certain, were deposited during a time of slow subsidence, and represent, I suggest and believe, the ancient soil and sub-soil torn from the land surface as the sea gradually gained upon the land by contemporaneous sinking. Apparently such deposits synchronise with the high-level (so-called glacial) drifts of Britain. Hence the bay-sculpture of Jersey took place *chiefly* during pre-Glacial times when the land was at a much lower level than at present, and was continued through a portion of the Glacial period when the island was slowly sinking still further. When upheaval came—as I believe it did—towards the close of that time, throwing the land much above its present level, and when a land-connection was brought about with France, the waves ceased to play havoc with the coast-line, retiring well to the eastward of the island. The beginning of this continental period was marked by the sojourn of Palæolithic man in Jersey, as evidenced by

the flint implements found in a sea-worn cave, of raised beach horizon, high up the lofty cliffs east of Grosnez Point. This continental period coming to an end in early historic time, the carving work of the sea has practically but recently recommenced, and at a much lower level than formerly.

Entirely different is the case of those dykes that lie more or less parallel with the coast. Locally known as "gutters," these form systems of canals which, in connection with the dykes at right angles to the shore line, are the potent factors that determine the breaking up of the rock area into innumerable minor reefs and islets. These gutters, humanly speaking, are veritable death-traps. The unwary, penetrating far sea-wards in search of fish or the harvest of wrack, often have their retreat cut off by the filling of these natural ditches long before they become aware of the fact. So constant, indeed, is this danger, that watch-boats, State-paid, hover, during the wracking season, around and among the more dangerous reefs.

Gutters have two very divergent faunas. Where the channels are wide and sandy-bottomed, communicating freely with open water at either end, banks of green, waving, grass-like Zostera—luxuriant sea-meadows—make good the footing, binding the sandy bottom into stable ridges. Such may be termed "canal gutters," as distinguished from the "drainage gutters" that carry off the water from the higher parts of the reefs as the tide runs down. Of the two, the former are the poorer in faunal diversity—but withal they are wonderfully rich. Upon the leafy blades of the Zostera, zoophytes occur in myriads. *Campanularia angulata* disputes place with the feathery *Plumularia similis* and with the graceful *Clytia johnstoni*. And upon these in turn, at certain seasons, brown hosts of diatoms descend in enveloping swathes. *Haliclystus*, also, often decks the green blades with its lovely brown bells. Soft gelatinous compound Ascidians (*Aplidium gelatinosum*) also clothe the blades; and in the breeding months of spring, molluscan and annelidan spawn—*Trochus*, *Nassa*, *Phyllodoce*, etc.—give diversity. The vivid green of the Zostera has had less colour-influence upon its floating population than one would naturally expect. I know of two animals only that are affected, but both are of striking interest. One is the large emerald-hued *Hippolyte viridis*, most lovely of the Prawns; the other, equally brightly-coloured, is a species of the Labridæ or Wrasses.

Quite a distinct and characteristic fauna gathers at the base of the Zostera stems, and upon their half-decayed remains. Most obvious are colonies of the brilliant orange-red Ascidian, *Botrylloides rubrum*, lying profusely about like tiny coral-beaded truncheons, beneath the concealing tangle of green. Little less conspicuous, and growing together with the *Botrylloides*, are snowy-white delicate masses that bespeak to the practised eye the endlessly branching calcareous sponge, *Ascaltis contorta*.

But, after all, interesting and varied as is the life that swarms

upon and among the Zostera, it is as nothing to that finding shelter in the half-loamy, half-sandy soil which the roots of the Zostera, in their increasing growth and decay, largely produce and firmly mat together. Very numerous are the worms. The tube-mouths of the shy *Sabella* (*Branchiomma*)*vesiculosa* opene verywhere. Siphunculids protrude delicate starry crowns in equally large numbers. Errant worms, too, are plentiful, and great gaping holes here and there bespeak the residence of one or other of the burrowing prawns. Molluscs are everywhere.

Examining the fauna of a drainage gutter, we get a wholly different array of life-forms and a hundredfold greater variety. If the great channels traversing the littoral from high- to low-water marks be valuable economically as highways for the wracking carts; if the canal gutters be useful to the fishers as saving weary hours of pulling against wind and tide, it is the drainage gutters—the least important in geological origin—that have the most zoological value as the breeding and sheltering grounds of innumerable animals. With very many creatures the presence of the last-mentioned natural channels makes all the difference between plenty and scarcity—indeed, I am convinced that many species, quite abundant on these coasts, would be difficult to include in the local fauna were it not for the advantages afforded by these gutters. The dykes thus marked are less eaten out than the others I have noticed. The dyke matter often comes to the surface at their upper ends, from whence a rapid fall of level leads to the outlet on the reef margin.

Obliterate the traces of life around and all would betoken the presence of a mountain torrent. Boulders of every size and shape strew the steep and rugged bed; this huge angular one, with riven side, might but just have fallen with thundering din, detached by frost-wedge from a neighbouring precipice; these of lesser size, with smooth surfaces and rounded edges, bespeak a long period of tumbling and rolling hither and thither. Here, too, as in a mountain stream, are bend-corners where, out of reach of the influence of the swift central current, accumulate great patches of gravel and shingle. In these drainage gutters littoral life flourishes in its greatest luxuriance. They form the true centres of the life of the shore, whence proceed in regular and ordered sequence vast colourising swarms of free-swimming larvæ. Two causes contribute. One is that, as these channels run parallel with the coast, their inhabitants are protected from the direct attack of storms, an important direct consideration to the more delicate organisms, and indirectly to the larger, which, in turn, feed upon the lesser. The second cause, and the greater, is, that these gutters, as soon as the tide recedes below their level, become swift-flowing streams, charged with minute animals and food-particles that have drained from the myriad weedy surfaces and chinks that one by one are exposed. This drainage-water, too, is rich in life-giving oxygen, absorbed from the air by the films of water as they drain from the tide-forsaken rocks.

It is difficult to convey even a faint indication of the wealth of life that settles in these gutters relying upon the current bringing plentiful food-particles within the reach of ciliary lashing. A complete list would be impossible, for it would be the cataloguing of three-fourths of the littoral fauna. Sponges and compound Ascidians are strikingly conspicuous; in species multitudinous, in colouring of every imaginable tint and combination—snowy-white, grey, pale yellow, orange, pink, scarlet, lavender, purple, black with white marblings, black with gold stars. These in a thousand grades of tinting occur in mingled patches, of size and form as erratic as the colouring, and give to the overhanging surfaces of the boulders chequered mantles of richness such as even Orient looms never expressed, though governed by minds most subtly appreciative of Nature's brighter aspects. Less striking are the pendant festoons of Polyzoa, hanging half-concealing before and between the crusting Sponges and Ascidians. Among all, wander, and often, too, demand lodging, great hosts of worms and tiny crustaceans not conspicuous as the others, but ever present, ever greatly numerous. Zoophytes and anemones are comparatively few, though *Coryne* at times may occur somewhat plentifully.

These drainage gutters are thus most conspicuously peopled by Sponges, Ascidians, and Polyzoa—animals in all cases living upon very minute food-particles, captured, or rather directed within the body, by the incessant lashing of cilia. Why they are so wonderfully common is due to the fact that the water that rushes past them as the fucus-covered reefs uncover, is laden richly with tiny animals and *débris* just suitable to the lowly mode of feeding practised by these animals. Once established, these colonies attract swarms of the free-moving worms and crustaceans—tiny freebooters, ever on the watch for loot.

Frequently the gutters drain large pools or chains of pools. These nearly always have similar dyke origin, sometimes marking the widening of the dyke fissure, sometimes denoting the point of intersection with another dyke of different direction. Such pools are commonly rich in life of the same species generally as in the gutters, but in lesser profusion. More Zostera grows in the pools, and zoophytes grow in greater numbers. Fishes, too, are more numerous, for the Pipefishes (*Syngnathus*), Sticklebacks (*Gasterosteus spinachia*), and the smaller genera of the Wrasses (Labridæ), and Prawns innumerable find in the dense plant-growth of these quiet, and often deep pools, just the safe hiding places and food preserves best suited to their needs.

JAMES HORNELL.

IV.

The La Plata Museum.

(*Continued from page* 35.)

THE above are some of the most noteworthy of the fossil mammals in the La Plata Museum from the Pampean beds and the somewhat older deposits of the Parana and Monte Hermoso; and I now pass on to the consideration of a few of the more interesting types from the still older Patagonian beds. Putting aside the Edentates, which I had no time to examine in detail, my observations will be in the main confined to the Ungulates, of which I made a special study. The most abundant, and at the same time one of the most interesting, of these early hoofed mammals is the one to which Owen applied the name of *Nesodon*, this genus being represented in the Museum by a vast series of remains, including many perfect skulls, as well as jaws, teeth, and limb-bones. Allied in many respects to *Toxodon*, these Ungulates differed by the closer approximation of their cheek-teeth to the Perissodactyle type of structure; the name of the genus being derived from a well-marked island-like lobe found on the inner side of the upper molars. There are likewise important differences in the conformation of the cutting-teeth, and also in the structure of the skeleton in general, which in many respects is much less specialised than that of the allied Pampean genus. Moreover, all the three species of *Nesodon* which I can alone recognise, were vastly inferior in size to the gigantic *Toxodon*, the smallest of the three being not much larger than a sheep. Hitherto, not much attention has been paid to the limb-bones of this genus; but I have been fortunate enough to identify not only the "long" bones, but likewise the calcaneum and astragalus, and thus to confirm the presumed close relationship of *Nesodon* to *Toxodon*.[1]

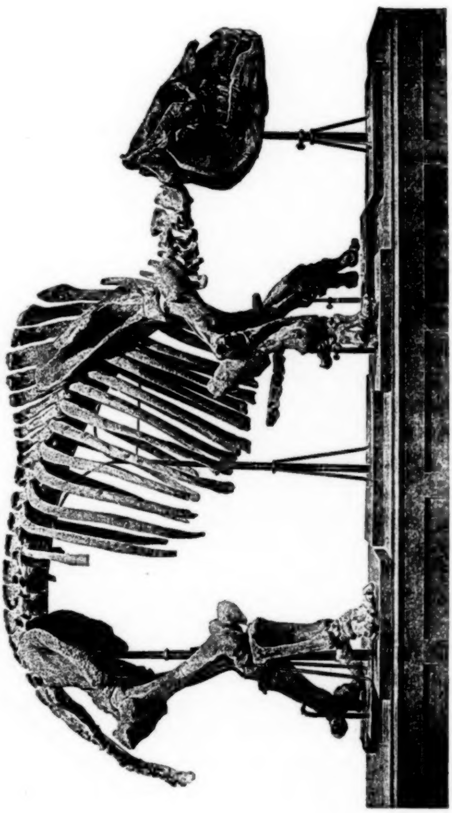
As our palæontological readers are probably aware, Owen described two species of the genus *Nesodon*, together with a third one which has been subsequently ascertained to belong to a totally different type of Ungulate. One of these two species (*N. imbricatus*) was an animal approaching the dimensions of a small rhinoceros, while the second (*N. ovinus*) was, as already said, not very greatly larger than a sheep. Between these two extremes I find an

[1] Some of these bones are described and figured in the forthcoming issue of the *An. Mus. La Plata*, containing an account of the results of my own work.

intermediate form which must apparently be recognised as a third species.

Having two imperfectly-known named species of a genus from a particular formation, one would naturally have thought that the object of the palæontologist would be to endeavour to complete our knowledge of those two species, and to hesitate to name new species (not to mention genera) from remains of the same group of animals from the beds in question, without the clearest possible evidence of their right to distinction. Such a method of procedure seems, however, to be utterly at variance with the views of certain South American so-called palæontologists, to whom the task of describing the fossil mammals in the La Plata Museum has been unfortunately from time to time confided. Instead of endeavouring to find out whether the specimens before them might not belong to one or the other of the two named species of *Nesodon*, they appear to have started on the assumption that almost every single bone or tooth that came under their notice must pertain to a totally new animal. In consequence, we have remains which clearly belong either to one or other of the two Owenian species, or to the above-mentioned intermediate form, assigned to something like a dozen genera (such as *Acrotherium*, *Adinotherium*, *Atrypotherium*, *Colpodon*, *Nesotherium*, *Gronotherium*, *Phobereotherium*, *Protoxodon*, and *Scopotherium*); while the number of nominal species must, I should think, be fully half-a-hundred. As a result of this extraordinary method of procedure, an enormous proportion of the specimens in the La Plata Museum are "types," whereby that institution is prevented from doing as much in the way of exchange as would otherwise be practicable. This remarkable ignorance of the first principles of odontological anatomy, and of the different forms assumed by teeth according to the ages of their owners, displayed by the palæontologists in question, surpasses belief, and there are certain specimens in the Museum bearing different generic names which even any ordinary student would say were identical. Indeed, on the principle (or, rather, want of principle) which appears to have guided the Argentine palæontologists, about a dozen species and some half-a-dozen genera might easily be made out of remains of the common horse. It is true that *Nesodon* displays an extraordinary degree of variation in the relative proportions of the large incisors in both jaws, but the gradual evolution of the adult from the young stage is indicated over and over again in the collection of the Museum; and with regard to the species founded on the evidence of the cheek-teeth, there is not the least excuse. This, however, is not all, for some of the so-called genera have actually been assigned to families apart from *Nesodon*; while the latter itself is separated, as a family, from the Toxodontidæ without the faintest shadow of justification.

I must, however, do one of the above-mentioned workers the justice of saying that he has at last partially seen the errors of his



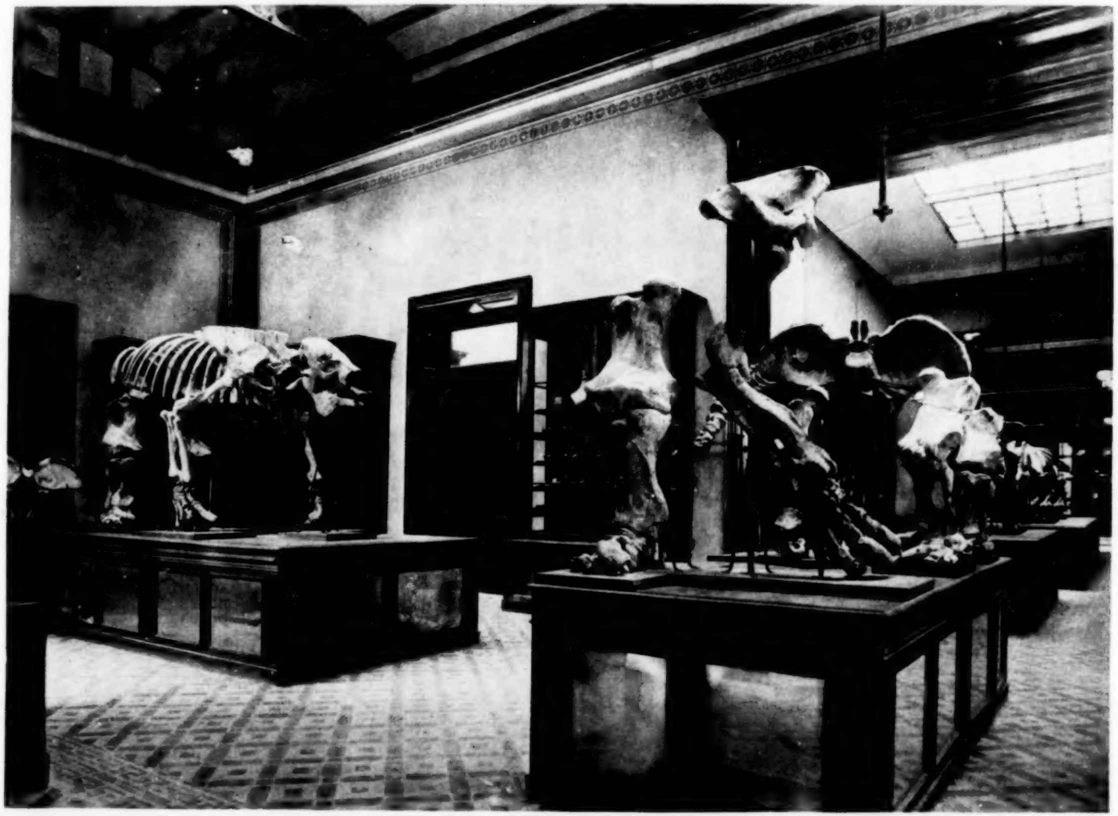
SKELETON OF *Toxodon*,

AS MOUNTED IN THE LA PLATA MUSEUM.

ways, and has tardily abolished some of the superfluous genera made by himself and his colleagues. His repentance comes, however, too late—after all the mischief has been done; and even then it is but half-hearted. He maintains, for instance, the genus *Acrotherium*, which is merely founded on specimens belonging to some of the three species of *Nesodon*, with a superfluous premolar tooth, probably caused by the first premolar having come up in front of the corresponding milk-molar, instead of replacing it; while the list of nominal species remains as long as ever. South American palæontological work has, indeed, already become a bye-word in England, but it is really far worse than I had any idea of previous to my visit to La Plata; and it may be worth the consideration of the Council of the *Zoological Record* whether it will not for the future be advisable to omit all mention of the majority or the whole of the names proposed by the Argentine palæontologists to whom I refer, as being mere useless encumbrances, instead of aids, to science.

Passing from this unpleasant portion of my subject to more agreeable matters, I may now call attention to two very remarkable members of the Toxodont Suborder, both being animals not larger than a rabbit, and exhibiting most marked rodent resemblances. The one of these is *Hegetotherium* from the Santa Cruz beds of Patagonia, and the other *Pachyrucus* from the deposits of Monte Hermoso. The latter of the two is distinguished from its ally by the tympanic bullæ being situated on the superior aspect of the skull and is so Rodent-like in general form and structure that it is almost difficult to believe that it is not an ally of the hares. It is, however, as shown by its teeth, clearly a member of the Toxodont Ungulata, and since it is perfectly evident that such an animal cannot have been the ancestor of the Rodentia, it follows that the Rodent resemblances presented by the more specialised Toxodonts must be due to parallelism.

By many writers the Toxodonts have been placed, with the Proboscidea and certain extinct suborders, in the Subungulata; they have, however, the alternating carpus of he Perissodactyla and Artiodactyla, coupled with the linear tarsus of the Proboscidea, while the astragalus is but slightly grooved, and the ca caneum carries a large facet for the fibula, as in the suborder last mentioned. These features clearly indicate that the Toxodonts (which are further characterised by some or all of their teeth growing for the greater portion or the whole of life) must form a subordinal group of equal rank with the Artiodactyla, Perissodactyla, and Proboscidea. Another subordinal group of extinct South American Ungulates, for which I have suggested the name Astrapotheria, is formed by the genera *Homalodontotherium* and *Astrapotherium*. Differing from the Toxodonts in having their teeth rooted at an early age, these Ungulates are further distinguished by having a perfectly flat astragalus with a head at the lower end for the navicular, while it is probable that both the carpus and tarsus were of the linear type. The cheek-



LA PLATA MUSEUM.

teeth are, moreover, exceedingly like those of the Perissodactyla, and more especially the Rhinocerotidæ, to which the members of this group approximated in point of size. Although there seems to be but one species of the first-mentioned genus and only two or three of the latter, the list of synonyms in the case of *Astrapotherium* is of the usual appalling length. As its name implies, the genus *Homalodontotherium* is characterised by the teeth being forty-four in number and forming an uninterrupted series, with the canines not longer than the incisors. Until recently this genus was known only by the teeth and jaws, but the La Plata Museum contains numerous specimens of the vertebræ and limb-bones. Among these, the humerus is remarkable for the great development of its deltoid crest, which recalls that of the wombat.

A very different animal is the gigantic *Astrapotherium*, the type species of which was originally described by Owen as *Nesodon magnum*. In this creature the dentition is reduced, and each jaw furnished with a huge pair of tusks, while the upper molars are extraordinarily like those of the rhinoceroses. There are no teeth between the huge upper tusks, which I have reason to believe are incisors; but in the lower jaw there are three pairs of small incisors, with curious spatulate crowns, situated between the pig-like tusks, which are here clearly canines. *Astrapotherium* has been placed among the so-called Dinocerata, but it is certain that such resemblances as it presents to that group must be attributed to parallelism, while its relationship to *Homalodontotherium* (as proved by the limb-bones in the Museum) is perfectly clear. It cannot, moreover, have any direct relationship with the Rhinocerotidæ, so that the resemblance of its molar teeth to those of that group is again apparently due to parallelism.

A third subordinal group of extinct Ungulates peculiar to South America is represented by *Macrauchenia* in the Pampean deposits, and by *Proterotherium* and certain allied forms in the Patagonian Tertiaries. These animals have been placed by some writers with the Perissodactyla, but it is certain that Professor Cope is perfectly correct in regarding them as representing a distinct suborder—the Litopterna. Agreeing with the Perissodactyles in having an odd number of toes, with the middle one symmetrical in itself, and likewise in the pulley-like upper surface of the astragalus, these Ungulates differ from that group in having both the carpus and the tarsus of the linear type,[2] and likewise by the fibula articulating to a small facet on the calcaneum (as in the Artiodactyla). Moreover, in those cases where they are known, the vertebræ of the neck are much elongated, and have the sides of the neural arch pierced by the canal for the vertebral artery in a manner now

[2] It may be well to mention that in the linear type of carpus and tarsus the bones of the two horizontal rows are set directly one over the other (as in the Proboscidea), whereas in the alternating type the bones of the upper row are placed over the divisions between those of the lower.

solely characteristic of the Camel family. Like the other suborders of extinct Ungulates peculiar to South America, the Litopterna further differ from both the Artiodactyla and Perissodactyla in having the bodies of the cervical vertebræ articulating together by flat terminal surfaces, instead of by a ball-and-socket joint. They likewise present the same strongly-marked similarity to the Perissodactyla in the structure of their cheek-teeth—a feature doubtless inherited from a common ancestor among the Condylarthrous Ungulates of the Eocene, but more or less specially developed subsequently by parallelism. The Litopterna are divisible into the two families of the Macraucheniidæ and Proterotheriidæ, the former being distinguished by the full and uninterrupted dentition; while in the latter the teeth are reduced in number and interrupted. An ancestral form of *Macrauchenia* is represented by the species of *Oxyodontotherium (Theosodon)* of the Patagonian Tertiaries, which were much smaller creatures than the Pampean animals, while an intermediate type existed in the Parana beds.[3] In this family, as well as in the next, I have again to deplore a superabundance of names, both specific and generic, as I have pointed out in the memoir referred to.

Among all these curious types of Ungulates, none are more remarkable than the Proterotheriidæ, as represented by the genera *Proterotherium* and *Diadiaphorus* of the Patagonian Tertiaries and the Parana beds. These were animals varying in size from a peccari to a tapir, with molar teeth more or less closely resembling those of the European Oligocene genus *Palæotherium*, but having only a single pair of tusk-like incisors in the upper jaw, and two pairs of lower incisors, one of which was much larger than the other. From the researches of Señor Ameghino, it is already known that in one member of this family (*Epitherium*), occurring in beds above the horizon of the Patagonian deposits, the feet were of the general type of those of *Hipparion*—that is to say, the middle toe was greatly developed at the expense of the two lateral ones, which were small and functionless. I find, however, from the evidence of the specimens in the La Plata Museum, that some at least of the Patagonian representatives of the family were likewise provided with feet of the same highly-specialised type, while I have no evidence that any of them had functional lateral digits.

This extreme specialisation of the feet of these otherwise generalised Ungulates is a feature interesting enough in itself, but it is of still more importance in regard to the relative age of the strata in which their remains occur. The Patagonian Tertiaries of Santa Cruz, from which the remains of Proterotheriidæ are obtained, appear to be nearly, if not quite, the oldest South American deposits yielding remains of land mammals. They are correlated by Señor Ameghino (who, by the way, suggests that *Proterotherium* and *Diadiaphorus* were

[3] For this form Señor Ameghino has proposed the barbarous name *Scalabrinitherium*, a term which may be changed to *Scalabrinia*.

animals provided with three functional toes to each foot) with the lower Eocene of Europe, while the Parana, Monte Hermoso, and other intermediate beds are assigned to the Oligocene and Miocene, and the Pampean deposits identified with the Pliocene. Now the fact that in the reputed lower Eocene beds we meet with animals having a foot as specialised as is that of *Proterotherium*, serves, to my mind, at least, to show the utter untenability of the hypothesis in question. We know that in the lower Eocene of both Europe and North America the Ungulates were all five-toed animals with brachydont, and generally tritubercular teeth; and if the South American Ungulates with feet of the *Proterotherium* type, hypsodont molars like those of *Nesodon*, or tusks of the length of those of *Astrapotherium*, were also of lower Eocene age, it would involve the existence of a mammalian fauna like that of the Puerco Eocene and London Clay in some part of the world during the Cretaceous epoch, from which the Patagonian Ungulates had originated. Of the existence of such a fauna there is, I need scarcely say, not only a total lack of positive proof, but likewise very strong evidence to the contrary. Then, again, the existence of a member of the existing genus *Dasypus (Zaëdius)* in the Santa Cruz beds renders it impossible to regard them as of lower Eocene age.

Moreover, in my forthcoming memoir on the fossil Cetaceans in the La Plata Museum, I have called attention to the circumstance that in one part of Patagonia there occurs a bed yielding Cetacean remains which appears to underlie the Santa Cruz deposits. Now this Cetacean bed most certainly is not of lower Eocene age, and is, indeed, probably Miocene, an identification which, if established, will at once overthrow the Eocene, or, indeed, Oligocene hypothesis of the Patagonian beds. Apart from this evidence, I am, however, quite convinced that the Patagonian Ungulates, owing to the specialisation of the feet in some cases and of the teeth in others, are not lower Eocene, or even Eocene at all, but are far more probably of Miocene age. The correlation of some of the beds lying between the Santa Cruz and Pampean deposits with the European Oligocene and Miocene likewise will not bear critical observation, and can, indeed, only be maintained by the creation of species or genera which have no existence save in the minds of their founders. For instance, I find it impossible to distinguish specifically the remains of *Typotherium* found in the reputed Miocene strata of Monte Hermoso from those of the typical Pampean form, while, as I have already shown, the so-called *Hipphaplus* of the supposed Oligocene Parana deposits is nothing more than a species of the Pampean genus *Hippidium*; and if we are to have Oligocene strata with a genus so close to *Equus* as to be doubtfully distinct therefrom, what possible grounds can there be for correlating them with the horizon so-named in Europe? I can believe, indeed, in the late survival of a generalised genus, but I utterly refuse to credit the occurrence of a

specialised one on a horizon far below its proper one. The proposal to regard the Pampean beds (which are some of the most recent-looking deposits I have seen in any part of the world, and contain evidence of the existence of man contemporaneously with the extinct mammals) as of Pliocene rather than Pleistocene age, is on a par with the above wild conjectures—for I can scarcely call them theories. In my own opinion, indeed, the whole of the series of fossiliferous strata from the Cetacean beds and the Santa Cruz deposits of Patagonia to the topmost Pampeans, may in all probability be included within the period occupied by the Miocene (perhaps inclusive of the upper Oligocene), Pliocene, and Pleistocene beds of Europe.

Another Patagonian mammal of great interest is one for which Señor Ameghino has proposed the name of *Pyrotherium*, and which he places among the Eocene Coryphodonts, although I fail to see the reason for the association. The type specimens include a premolar and molar tooth, as well as a tusk, but I have reason to believe that the latter pertained to *Astrapotherium*. The molars of this gigantic animal resemble those of the Australian extinct *Diprotodon*, and the last two molars of the Proboscidean genus *Dinotherium*; and it hence seems that these teeth are insufficient to determine the affinities of this strange creature. The type specimens were obtained from Neuquen in Patagonia, but others in the Museum come from Chubut, in the same country. The latter were found in association with remains of *Astrapotherium*, *Homalodontotherium*, and *Nesodon*, thus showing that the horizon of these beds is identical with, or very near to, that of the Santa Cruz deposits. In a paper published some time ago in *La Revue Scientifique* by Dr. Trouessart, from notes supplied by Señor Ameghino, it is stated that *Pyrotherium* occurs in beds yielding Dinosaurian remains; but this must, I think, be now regarded as incorrect. Possibly a fragment of a very large tusk from Chubut of a Proboscidean type may belong to *Pyrotherium*, in which case the genus would probably have to be regarded as allied to *Dinotherium*. The section of this tusk is egg-shaped, with a maximum diameter of about four inches. As in *Dinotherium*, the dentine does not show decussating striæ.

Omitting any reference to the large collection of Edentates, Rodents, and Marsupials from the Santa Cruz beds of Patagonia contained in the Museum, we may pass on to the Cetacean remains mentioned above, all of which are contained in the same gallery as the land-mammals from Patagonia. Several of these Cetaceans are of especial interest, on account of their exhibiting generalised features unknown in any of their living relatives, and thus afford very important evidence in regard to the phylogeny of the two existing subordinal groups of this order. Although of less wide interest than most of the others, one of the finest specimens in this series is the nearly entire skull of a small baleen-whale, which, from the evidence of the tympanic bone, I have assigned to the European Tertiary genus *Cetotherium*. Like the other remains, this skull

was obtained from a sandy deposit a short distance from the shore at Chubut. Most of the other remains are those of toothed-whales, among which a fine, though somewhat imperfect, skull of a small form allied to the sperm-whale claims special attention. As our readers are doubtless aware, the whole of the existing members of the sperm-whale family are characterised by the absence of functional teeth in the upper jaw, those in the lower jaw varying in number from more than twenty on each side to a single pair. The Patagonian skull shows, however, a full series of large conical teeth in both the upper and lower jaws, these teeth being not unlike those of the sperm-whale, although furnished with thin caps of enamel on their crowns. The skull has the same general form as that of the cachalot, displaying a large and deep frontal cavity for spermaceti. From the structure of the teeth I have identified this skull with the European Tertiary genus *Physodon*, which has hitherto been but very imperfectly known; and since its inclusion in the Physeteridæ would render that group very difficult to define, I have suggested that it should constitute a family by itself. Another member of the same family is represented in the Museum by a smaller cranium, to which I have assigned the name of *Hypocetus*. A totally different type of Cetacean is presented by a small skull with teeth of the type of those of the European Tertiary genus *Squalodon*, but differing from the latter in number. This difference alone I should not have regarded as of generic value, but an examination of the nasal region showed the presence of prominent nasal bones projecting over the nasal cavity in a manner quite unknown in any living member of the suborder, and I accordingly consider this form as the representative of a new genus, with the name of *Prosqualodon*. Precisely the same feature, although in a more exaggerated degree, is displayed in the nasal region of an exceedingly elongated and dolphin-like skull, with simple teeth, which I have described under the name of *Argyrocetus*. From its general characters, I refer this skull to the Platanistidæ, but it differs from that of the three existing genera of that family by the symmetry of the narial region, and the projecting, wedge-shaped, and roof-like nasal-bones. Although the discovery, sooner or later, of toothed-whales with projecting nasals and symmetrical skulls was a thing to be expected, yet the absence of any evidence of the existence of such forms hitherto has been regarded as a bar to the derivation of the baleen-whales from the toothed-whales. This obstacle has now been removed by the discovery of these two extinct genera in the Patagonian Tertiaries, and it is possible that future investigations will show that certain other features, which have been regarded as indicating a dual origin for the two groups in question, admit of another explanation. The inclusion of these two forms in the Odontoceti (and they certainly cannot be regarded as representing a distinct group) must, to some extent, modify the ordinarily-

accepted definition of that suborder. The last of the Patagonian Cetaceans is represented by two skulls, which indicate a rather large member of the Delphinidæ, with a somewhat elongated snout. This form, which I have proposed to designate by the name of *Argyrodelphis*, differs, however, from all existing dolphins in that the hinder teeth are furnished with minute fore-and-aft cusps, thus showing another ancestral feature among the Patagonian Cetaceans.

Concerning the collection of remains of giant birds from the Santa Cruz deposits in the La Plata Museum, so much has of late years been written, and the plates accompanying the memoir of of Señores Moreno and Mercerat are so excellent, that it will be unnecessary to say much in this place. It is, however, certain that the number of generic names which have been published is much too large, and that the name *Phorosrhachus*, originally proposed by Señor Ameghino, has the right of priority. Apart from their gigantic size, these birds claim especial attention on account of the extraordinary size and massiveness of their skulls, as attested by the form of the mandibular symphysis, of which there are several examples in the Museum. Although, in the memoir referred to above, these birds were arranged under several family and generic heads, I am in accord with Señor Ameghino in regarding the whole of them as pertaining to a single family, the larger members of which may be subdivided into two genera, *Phororhacus* and *Brontornis*. In the former the symphysis of the lower jaw was long and narrow, its length when entire being probably about 7½ inches, and its maximum width 2½ inches. In the more massively built *Brontornis*, on the other hand, the sympyhsis was very broad and short, while the margin of the jaw was remarkable for its extreme curvature, the tip being sharply inclined upwards. The approximate length of the whole symphysis is 5½ inches, and the width about four inches. This type of jaw seems quite unlike that of any living group of birds.

Of the cranium, the Museum possesses two fragments, neither of which are figured in the memoir of Señores Moreno and Mercerat. One of these comprises the occipital and parietal regions, imperfect on the left side, where it shows a cast of a portion of the brain; while the other is a part of the left side of the cranial box, with the quadrate in position. From the latter I was fortunately enabled to detach the greater part of the quadrate, and was thus able to learn that this bone was articulated to the cranium by two distinct heads, and that it was apparently not overlapped by a descending process of the squamosal. Both these being essentially Carinate characters, it seems evident that the Stereornithes cannot be included in the Ratitæ; and that they must consequently either be placed among the Carinatæ or form a group by themselves.

This group, in which *Gastornis* may have to be included, will perhaps turn out to form the connecting link between Carinates and Ratites.

Their vertebræ were highly pneumatic; but the hollow leg-bones appear to have been devoid of pneumatic foramina, and during life were probably filled with marrow, like those of existing Ratitæ. In *Brontornis* the tibia has a length of 30 inches, while the metatarsus measures 15¾ inches in length, with a width of 5½ inches at the upper end, and 3 inches in the middle of the shaft. Although displaying a similar depression at the upper part of the front of the shaft, the metatarsus of *Phororhacus* is a much more slender bone, the length in one species being 15¾ inches, with a maximum width at the upper end of 3¼ inches, and of 1½ inches at the middle of the shaft.

The much smaller imperfect metatarsus figured under the name of *Palæociconia* is regarded by Señor Ameghino as inseparable from *Phororhacus;* but from the circumstance that the foramen between the third and fourth trochleæ perforates the bone at right angles, instead of descending obliquely so as to open inferiorly on the lower aspect of the bone between the two trochleæ, I am inclined to think that it has a right to generic distinction.

The whole of the remains noticed above are from formations of Tertiary age, but the collection of fossil vertebrates does not end with that period. From certain deposits in the districts of Chubut and Neuquen, in Patagonia, which are probably of Cretaceous age, there have been obtained a large series of Dinosaurian bones pertaining to reptiles rivalling in size their most gigantic European and North American allies. One of these creatures, although by no means the largest, I have referred, in a memoir about to be published by the Museum, to the genus *Titanosaurus*, originally founded, on the evidence of caudal vertebræ, from the Cretaceous rocks of India. These vertebræ differed from those of all other gigantic Dinosaurs in having a cup at the anterior end of the centrum, and a ball at the opposite extremity, thus resembling those of existing crocodiles. The large series of specimens in the La Plata Museum serves to show that *Titanosaurus*, as had been previously suspected, is really a member of that group of Dinosaurs to which the name of Sauropoda has been applied. This is clearly shown by a fine dorsal vertebra exhibiting the well-known lateral pits characterising that suborder.

In these vertebræ, it may be observed, the cup is situated at the hinder end of the centrum, and the change of type is effected by means of the first caudal vertebra, which, as in crocodiles, is biconvex. The bones of an enormous fore-limb, together with an imperfect femur and two caudal vertebræ, indicate a still more stupendous member of the same family, for which I have suggested the name of *Argyrosaurus*. In the type specimen the length of the humerus is nearly the same as in the gigantic humerus from the Kimmeridge Clay preserved in the British Museum, and mentioned in the *Catalogue of Fossil Reptiles* under the name of *Pelorosaurus humerocristatus*. A smaller Dinosaur, characterised by the slight development of the lateral pits in the vertebræ of the trunk,

and hence named *Microcœlus*, appears to indicate a type unknown either in Europe or North America, while two vertebræ point to the existence in Patagonia of a Dinosaur more or less closely allied to the European *Megalosaurus*. With the discovery of these interesting Dinosaurs in Patagonia, we have now evidence that this extraordinary group of reptiles was represented during the upper half of the Secondary epoch by allied forms throughout the greater part of the world, their remains having now been obtained from Europe, India, Australia, South Africa, and North and South America. The vertebrate land fauna of the world seems therefore at that comparatively early epoch to have been much more homogeneous than it has ever been since, while there is no evidence of any marked distinction between the types of life inhabiting the northern and southern hemispheres.

To give an exhaustive account of all the treasures of the La Plata Museum would entail an amount of space far beyond that which is here available, but I trust that the foregoing brief sketch may convey to the palæontologists of Europe some idea of the richness and interest of the collections which are stored in the handsome building in La Plata. The Government are, indeed, to be congratulated on having founded such a noble institution as the Museum; and it is to be hoped that, when the scientific value and importance of its contents are more fully realised, they will not refuse such financial support as may be necessary for ensuring their preservation, and for making them known to the world at large by means of suitable publications.

It is not, however, solely as a geological, palæontological, and zoological institution that the Museum of La Plata demands admiration and support. It is likewise a great printing and chartographical establishment, where Government documents and maps are produced with a speed worthy of all commendation. The aim of the Director is, indeed, that the Museum should eventually display the entire evolutionary history and the whole of the natural products of Argentina; while it should at the same time be the depository of the whole of the data relating to the geography and topography of the country, and the place where all information on such subjects should be readily accessible to the public. For the success of this grand and noble scheme the Director has, as he deserves, our most cordial good wishes.

In conclusion, I have the pleasure of tendering my most hearty thanks to Dr. and Mrs. Moreno for the hospitality and unvarying kindness which I received at their hands during my brief but pleasant sojourn in La Plata.

RICHARD LYDEKKER.

Las Bandurrias, La Colina,
Buenos Aires,
November 3rd, 1893.

V.

Plant Diseases and Bacteria.

BOTANISTS have always been justly proud of the fact that they had a fully-established germ-theory of plant diseases at a time when this explanation of the diseases of man and animals was only beginning to dawn on pathology; that they showed the way, and in many cases (not the least important) invented the methods which the modern bacteriologist has re-discovered and certainly perfected. This botanical germ-theory was, in one respect, more obvious and easy of discovery than the animal one. It dealt with fungi, which though minute and elusive enough to defy all but the most patient and cunning investigation, are yet far more tangible organisms than bacteria. The brilliant work of de Bary and others in tracing the life-histories of parasitic fungi through generations inhabiting successive host-plants of diverse kinds has no parallel among the investigations of the bacterial diseases of man and animals. On the other hand, botanists must admit the reproach that, while they have concentrated their energies on the micro-organisms that produce the disease—naturally enough, since these are plants as well as the hosts—they have neglected the study of the diseased host, and that consequently plant pathology in the strict sense is in a comparatively backward state. This, fortunately, has shown signs in recent years of being remedied by increased attention; and one of the fruits of such attention most to be desired, viz., a better understanding of what is meant by *immunity* and *predisposition*, can be reached only by this path. There is hardly any subject in the whole of scientific literature and conversation about which there is more vague writing and talk than predisposition. There is a very small measure of bread and "an intolerable deal of sack." How it may be exactly with human beings and animals, I am not qualified to say, and I expressly exclude them from these remarks; but no burning and shining light on the subject has reached botanists from this source, and I strongly suspect, from my insufficient knowledge of the matter, that here too there is little to be said but much to be doubted.

Some years ago, when there was more public, and perhaps less private, attention paid to such subjects as the diseases of the potato, cereals, and other crops, it was a favourite view of farmers, gardeners, and even of more exalted personages, that these cultivated crops had

developed, through what was vaguely called "over-cultivation," an inherent tendency to disease, just as we hear a great deal about the "diseases of civilisation," and so on. There may be something in this, but no one has ever proved that there is, and, meantime, one must be content with the apparently sufficient explanation that the cultivation of crops in close contiguity gives the parasitic organisms opportunities of spreading superior to those commonly found in nature (though not so much so as might readily be supposed), and also affords the spectator a better opportunity of witnessing the effects, and attracting his attention, from the fact that the diseased plants were valuable to him, much more than wild plants, for example. One cannot resist suspecting that some of the so-called "diseases of civilisation" are in the same boat. We know that such as are infectious are often infinitely worse among uncivilised communities, among whom they possibly originated, and such as are not infectious are sometimes, at least, imaginary ailments, or ascribed to civilisation on wholly inadequate grounds. But these things are leading me away. We certainly do not know that there is an "inherent tendency to disease produced by over-cultivation," and we do not even know if there be such a thing as an inherent tendency to disease at all. The fact that one species is taken by a parasite and another left, that one variety even may escape wholly or partially while others suffer, shows us that there may be something of the kind; but, on the other hand, the tendency is better described as on the part of the parasite; the predisposition may be in the environment of the host, and, lastly, need not be a sickly or enfeebled condition of the host, for that is generally what is meant.

It may not be too tedious if I venture to recall that these fungi and bacteria all gain their living as *parasites* producing diseases in living bodies of plants and animals, or as *saprophytes* feeding on their decaying bodies or dead organic substances. Between the *strict parasites* and *strict saprophytes* there are, however, intermediate forms, such as parasites that are *facultative saprophytes* and saprophytes that are *facultative parasites*. Finally, we have in the lichen-forming fungi, for example, cases of commensalism in which a lasting nutritive partnership is struck with the host instead of a one-sided arrangement, as in the other cases. It will be seen, therefore, that there is a considerable range of nutritive adaptations among these organisms—a certain elasticity of accommodation. Among the parasites, which principally concern us, we have such as are facultative saprophytes and the converse, and we have others that are almost omnivorous parasites, attacking plants of diverse groups; others confined to an allied group of species; others to a single species. Among them there are noteworthy instances of parasites that attack hosts outside the group mostly affected, and others again that exempt particular species and even varieties within the group of hosts. Consideration of such instances rouses curiosity as to the exact cause of immunity,

or of predisposition, on the one hand; or, to put the matter otherwise, as to the gradations in the aggressive behaviour of a parasite to the different varieties or even individuals of a host. It is just here that we leave sure ground in most cases, but there is one remarkable instance, at all events, of which our knowledge is sufficient—that of *Pythium*, which, as a facultative parasite, attacks flowering plants. The host here displays degrees of predisposition or power of resistance in proportion to the amount of water it contains—a condition not in itself sickly. We know further—it is abundantly evident that sickliness is not always necessary to predisposition in plants, but, on the other hand, it may frequently be so. At one extreme we have the parasite which is the complete master of its host under favourable external conditions—as much its master as the animal that devours it in more summary fashion; and, at the other extreme, we have parasites which need such adventitious aids of access to their hosts as wounds and abraded surfaces, etc. The subject is a very wide one, and merely the salient points are being touched on here, but I must cite the facultative parasitism of moulds that grow on fruits, to be referred to again later.

One of the most interesting general truths in all this web of fact is the exemption of living plants from the assaults of bacteria. I reserve certain possible exceptions, such as Wakker's hyacinth disease. This exemption has been generally accounted for by the acid reaction of plants, and I might venture to suggest that, since more causes than one commonly co-operate in such matters, the comparatively strong illumination of the vitally active above-ground parts of plants may partially aid in this direction. Recent researches have demonstrated the exceptional powers of sunlight as a retarder and destroyer of Bacteria,[1] and Professor Ward, who has re-examined the whole question fruitfully, has pointed to the protective powers of the pigments of such parasitic fungi as Uredineæ, etc., against this influence—a protection not shared by bacteria.

The question of the relations of bacteria to plant tissues has recently been discussed by Dr. H. L. Russell[2] in a thesis for his degree at the Johns Hopkins University. He complains at the outset of the neglect or the sceptical reception by European writers of the case of the pear-blight caused by *Bacillus amylovorus* which, he contends, has been established by Professor Burrill, and he cites in an appendix tables of bacterial plant diseases, many of them, it is to be feared, in like case with the pear-blight. In some of these diseases the bacteria

[1] *See* Raum. "Der gegenwärtige Stand unserer Kenntnisse über den Einfluss des Lichtes auf Bacterien, etc." *Zeitschr. f. Hygiene*, Bd. vi., 1889. He cites some 150 papers dealing with the influence of light on bacteria, etc., and more or less agreeing in this—that light exerts an adverse influence on pathogenic bacteria, and a stimulating one on healthy processes in the animal body.

[2] "Bacteria in their Relation to Vegetable Tissues" (The Friedenwald Co., Baltimore).

attack the starchy stores of reserve-material or the sugary fruits of the hosts, and it is precisely here that, as has been mentioned above in the case of fungi, thin partitions divide the saprophyte from the parasite. On the other hand, there are cases, like the blight on oats, where all parts of the young plants are affected, and, in short, there is a pleasing variety in the organs attacked. I am far from denying all these cases, but in matters of this kind it is, above all, necessary to "prove all things," and I prefer to retain, at all events in some cases, a "skeptical" attitude, especially as the data we possess are "meager." Not so, however, with Dr. Russell's own experiments, which are a valuable contribution to the literature of the subject, and a most promising performance. Some of his statements are open to comment, if not to criticism, on minor points, but this is hardly the place for a discussion of methods, etc., and the whole thing is so interesting a study in immunity that I summarise his conclusions. "The artificial inoculation of higher plants with different micro-organisms (not known to be pathogenic for plants) reveals the fact, contrary to the usually-accepted idea, that quite a goodly number of different species are able to withstand the action of the living plant organism for a not inconsiderable length of time." Of these he finds saprophytes particularly prominent—but not all equally so. Facultative parasites on the animal body were not found to be adapted to live in plant tissue, with the exception of *B. pyocyaneus* and the Schweineseuche *Bacillus*. "The inoculation of plants, not taxonomically related to the natural hosts of bacterial plant parasites, with species of micro-organisms naturally parasitic on vegetable tissue, showed that while the bacteria were unable to spread, they could survive at the inoculation point in large numbers. . . . Not only were numbers of different species of bacteria able to *live* in the plant from 40 to 80 days or more, but many of them (mostly saprophytes) were able to *spread* throughout the tissue of the plant to a limited extent (20 to 50 mm. or more)." This spreading was generally intracellular, not intercellular, and always in an upward direction. Dr. Russell thinks that this was not owing to the transpiration stream, but to the actual growth of the micro-organism. In the case of bacteria entering by wounds, he thinks it possible that they could enter through lesions so small as to escape notice, and that they might even live in the tissue after the wound has healed over. "In the case of parasitic species on plants, they sometimes effect an entrance into tissues without the intervention of wounds of any sort." The exemption of plants from bacteria in general, he distinguishes as *resistance*; while he reserves the term *immunity* for "the ability of a certain group of plants to be refractory towards a disease germ that is able to cause a pathological condition in closely-allied forms of plant life." This certainly seems an unnecessary distinction, because it is scarcely possible in any case to draw the line for immunity unless one is a "harbitrary gent," though the

idea that underlies this proposal is one generally recognised. At the present stage of our knowledge, or ignorance rather, of resistance, immunity and predisposition, it is hardly wise to introduce binding definitions of useful general terms. His other conclusions are of a more general and obvious kind, but the whole paper is permeated with the true spirit of research and experiment, and its author, if as yet somewhat credulous, deserves congratulation on a very promising piece of work.

GEORGE MURRAY.

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GEORGE MURRAY.

VI.

The Causes of Variation in the Composition of Igneous Rocks.

FEW questions occupy a more important place in the mind of the physical geologist at the present time than why, within certain limits, the composition of eruptive rocks varies. Numerous opinions have at different times been expressed, but none of them have stood the test of time, nor have they at any epoch been universally accepted.

When we come to consider in general these different views—maintained, many of them, by both careful observers and clear thinkers—we find that they fall into two groups. There are those who hold the existence of two extreme pastes, the mixing together of which affords all the intermediate varieties of eruptive rocks; while the opposite school are equally confident that from a single original paste have been derived the numerous varieties of igneous rocks.

Numerous theories have been suggested to explain the differentiation of the two extreme pastes as held by the first school, and these explanations, with others, have been based on the action of the same agents as those which differentiate the common magma believed in by the second school.

Many of the hypotheses grade into each other, and some authors hold more than one agency at work; while others are somewhat mixed in their ideas as to the influence of one cause as separate from another.

As for the first school, they maintain that either whole or part of the fluid rock portion of our earth was, at one time or another, separated into a number of concentric shells, just as we find air separate from water.

This, at first sight, seems highly plausible; and I think we can concede they are right when they consider forms of matter of totally different molecular structure, such as air, water, oxides, and metals, just as we could confirm the same truth with such substances as mercury, chloroform, water, and oil, which remain separate when poured into a tube, in the order of their density, and, however much they are mixed together, separate again.

With volcanic rocks the question is somewhat different. The fundamental paste of these is composed almost entirely of oxides—some basic, others acid, but the complete intersolution or miscibility of which, in a fused state, has never been disproved, nor does it seem likely to be, as they all have a common tie in oxygen. When they cool, then other conditions are introduced, which do not concern us at present. Soret's principle will, no doubt, be urged against this statement; but in that case we have to deal with experiments on bodies much less nearly related, and under conditions of far less viscosity than those of an igneous paste, and with extremes of temperature far different to those likely to occur in masses of the enormous dimensions of the earth. Neither must we neglect the influence of tidal action, convection currents, and many other mechanical disturbances, such as shearing between the different fluid shells in the direction of the earth's rotation, supposing such continuous fluid shells to exist within our earth at present. In the case of localised reservoirs, there would be the absorption of water, vesiculation in the paste, currents sent up by the injection of earth fissures, or eruption of some of the material on the earth's surface, and other mechanical disturbances.

The oxides fused together in the manufacture of glass, which vary still more in their relative specific gravities than those which constitute igneous rocks, are not known to separate in the glass pots, however long they are left quiet. It may be objected that the depth, time, and even, perhaps, temperature are hardly comparable in the two cases, but we must not forget that even the most basic glasses are markedly viscous at high temperatures. These views may conveniently be styled the "differential paste and alloy hypothesis."

Mr. C. E. Dutton[1] says, "We know of no natural processes capable of separating the more acid parts of such a magma except the chemistry of the atmosphere acting at temperatures far below the melting-points of the silicates." He urges the following chemical argument against such a hypothesis:—The separation of a magma into two or more degrees of acidity is disproved by the low percentage of silica in basalt not being confined to the felspar and augite, but being also in the base, while the high percentage in rhyolite is in the felspar, and still more in the base. Hence the segregation must have affected the base more than the crystals.

The only way out of this difficulty is to suppose crystal segregation and refusion without subsequent mixing. I do not deny the possibility of such a process occurring occasionally; but to imagine that under every volcanic region, and under a large number of individual vents, there is an apparatus as complex as a chemical factory or an iron foundry, can only be relegated to those fantastic theories of volcanic magic that pass for science.

[1] "Geology of the High Plateaus of Utah," 4to, Washington, 1880, p. 124.

Neither is the idea of the segregation and settling down or deposition of certain crystals a very comprehensible one. It is hard to deny that such a process might take place, but it seems highly doubtful that any but very large crystals could undergo sinkage in a highly viscous medium; besides, it is not true that minerals separate in the order of their basicity or of their specific gravities, a fact I pointed out several years ago.[2] Leucite, for instance, is only formed in the open chimney of a volcano, and depends, like some of the augite, with probably sodalite, haüyne and nepheline (in some cases only), on the liberation of the alkalies and alkali-earths from their chlorides and sulphates by the dispersal and escape of their acid radicle vapours. These bases can then take up the silica from the residual basic glass, thus forming leucite and magnetite.

Again, we find that several mineral species become individualised contemporaneously. In many rocks, felspar and magnetite or augite, or again augite and leucite, were certainly separating at the same time; now if these sink together we shall have a rock of rather curious composition. Brögger and Vogt seem to believe that segregation takes place at certain points of a reservoir where the conditions are more favourable to the crystallisation of the one or the other mineral species. This much appears not improbable, and would easily explain the peculiar iron ores described by Vogt, and many rocks that have cooled in place, but it is hardly applicable to igneous effusive rocks in general.

Other suggestions that have been offered may be denominated the "fusion hypothesis," and the "osmotic hypothesis." Professor Sollas has demonstrated how, in some Irish igneous rocks, fragments of other igneous rocks of different composition and earlier date have been dissolved in a later magma.[3] Bäckström[4] and Fromm[5] have likewise described the local changes produced by quartz and felspar inclusions in basic rocks, but their observations are limited to the immediate neighbourhood of the enclosures. The former author found three kinds of augite in the enclosing rock. I have likewise shown that in basic and andesitic rocks of Stromboli quartz is fluxed down, forming with the residual basic glass an augite which becomes an important rock constituent.[6]

These facts in themselves are not of paramount value in the question, but they are clues to an important line of investigation that, when more carefully pursued, may afford valuable evidence as to change of composition in a primitive paste by adulteration with extraneous additions.

Ricciardi, on the evidence of his careful and elaborate analyses of

[2] *Scient. Proc. R. Dublin Soc.*, n.s., vol. v., p. 143, *et seq.*
[3] *Rep. Brit. Assoc.*, 1893.
[4] *Bihang t. k. Svensk. Vet. Akad. Handl.*, vol. xvi., pt. ii., no. 1.
[5] *Zeitschr. deutsch. Geol. Ges.*, vol. xliii., p. 43.
[6] *Rep. Brit. Assoc.*, 1893.

Italian volcanic rocks, suggested that the original paste was acid in composition, and that it became converted into basic rocks by the fusion of the Apennine limestone which supplied it with lime, magnesia, and iron. Herrick, Clarke, and Deming, although they do not go so far as Ricciardi, believe that basic rocks may be made more acid by the influence of the enveloping or "country rock," as they call it. They make no definite statement as to whether this is by fusion or chemical interchange.

The feeble point of Ricciardi's hypothesis is that, however magnesian or ferriferous be the Apennine limestone (for the numerous analyses of which we are indebted to that author and Abich), the amount of lime would be excessive in proportion to the other bases taken up by the lava.

For years I have been strongly impressed by the probability that, after all, we may have only one fundamental paste. It is not unlikely, admitting either a fluid shell between the earth's crust and nucleus, or even large isolated portions of such a shell, that this, during long ages since our globe consolidated, has been modified in composition by the rounding off of projecting inequalities of the undersurface of the crust or roof where thickenings and crumplings had taken place while cooling. Not only might the primitive cooled fusion-crust be reabsorbed, but the earlier sedimentary deposits might be likewise consumed, so that anterior to any fissure-filling a large extent of igneous paste would have changed in composition; but in such conditions I have little faith. Physicists will have it that our earth is practically a rigid mass; that pressure raises the temperature of solidification; and that therefore igneous rock at any considerable distance from the surface is solid, although at a very high temperature. In what way, therefore, can the "focal diffusion" and "segregation" processes have gone on? So far we have no evidence of segregation in a pure solid, but only in those solids wetted or permeated by a liquid. One escape from this difficulty is suggested by the last remark—namely, that perhaps this solidified mass of incandescent rock is composed of quite different minerals to those which reached the surface, undergoing liquefaction on the way; and that some silicates remain fluid and act as the diffusion agent. In fact, there is a complete analogy to what occurs in a marl, limestone, or clay, when water serves as the medium for the concretion of limestone, pyrite, flint, and other nodules; or for the more complete crystallisation of pyrites, selenite, hauerite, etc. But in all such cases the segregation is diffuse; by which I mean that in a stratum of marl we do not find the lime at one locality or part of the country and clay at another, but we encounter the resulting concretions scattered through the clay. If we imagine this to be suddenly fused, the resulting rock would have the composition of the original mud, and supposing that all issued by one vent, or cooled in place, we should not have a limestone rock here and a clay there.

But it will be argued that this segregation will occur in the primitive igneous material after it has liquefied by diminished pressure, and is on its way towards the surface. Then, it is true, it frequently occupies tortuous fissures where differentiation and segregation or sedimentation of crystals of the constituents might go on; but this could hardly explain the regular flow of definite but very different types of rocks from numerous points along a line of active vents, such, for instance, as the Lipari Islands. Here we observe, along a stretch of some 50 miles in length, a series of numerous vents from which outpours of basic dolerites and andesites simultaneously took place, and overlapped effusions of intensely acid lavas. In Vulcano for 2,000 years eruptions of an obsidian lava and a dolerite have been going on at vents only a mile apart. Is it conceivable that differentiation could progress, in the great fissure supplying these volcanoes, to such a complete extent that, without a difference of time, and in such a limited area, two extreme rocks could be poured forth and almost practically none of intermediate composition? What is said of this region is no less applicable to many others.

There yet remains one other possible cause, foreshadowed as far back as 1876 by the late Mr. J. C. Ward; that is, the interaction of the primitive igneous paste and the rocks it traverses or comes in contact with in its way into and through the earth's crust. Mr. Ward did not state clearly whether he meant by simple fusion of the walls of a volcanic canal or by a process of osmosis.

In my paper on Vesuvius and Monte Somma,[7] I drew particular attention to the subject, and in later writings those views have been extended and confirmed, but it will be advisable here to discuss the question in some detail. When we observe the denuded roots of volcanoes we find a certain amount of rock that has disappeared and has been replaced by the igneous intruder. We have little evidence in most cases to tell us whether the removal has been by mechanical export, fluxion, or fusion, though in many cases evidence points to the first as the principal means. I think it may be stated as a general law that contact metamorphism increases in intensity with the bulk of the igneous intrusion and the coarseness of its crystallisation. In other words, it is greater the larger is the amount of the heated medium, and the longer time this takes before solidifying, and, therefore, before its subsequent cooling. In contact metamorphism in regions which show evidence of being for a long time active volcanic centres, very marked chemical changes have been wrought in the solid rock—*elements have been introduced and* OTHER ELEMENTS HAVE BEEN REMOVED. All the elements introduced are derived, I presume no one will deny, from the neighbouring paste, which will have been modified in composition according to the percentages of those elements that passed into the cavity walls.

[7] *Quart. Journ. Geol. Soc.*, vol. xl., p. 54.

I claim, also, that the same paste has acquired those elements that have disappeared from the encasing rock. The change in composition of a lava by one only of these processes would not be very great, but when both are considered the change of an acid to a basic rock, or *vice-versâ* is quite possible.

In my paper on the ejected blocks of Monte Somma[8] (I. stratified limestones) and that on eozoonal structure in the same, by Dr. J. W. Gregory and myself, now being published by the Royal Dublin Society, it has been shown that calcareous rock acquires silica and later alkalies, and loses lime and magnesia in such a way that the magma, actually cooling in contact with it, is often reduced to an ultrabasic one. Are we not to suppose, therefore, that a less intense change does take place at a greater distance and under less favourable circumstances than these extreme and rather localised ones? Again, when we examine great areas of intrusive acid rocks, we often find their peripheral regions becoming more and more basic, and, perhaps, cases may be recorded of the reverse, according to the country rock. That these gradations are irregular is nothing more than we should expect, for the country rock surrounding such a mass will also vary in composition, and then circulation of the paste towards volcanic vents may have been greater at some spots causing mixing or carrying away the material. For succinctness we may call this the "osmotic" hypothesis.

If we suppose a number of vents, scattered over such an area, to open, the outpouring lava would differ according as it was derived from the purer or from the altered paste. A vent might drain out all one kind of paste, and following this might flow another of a different composition. The order in the composition of the rocks that issued might depend, therefore, on quite accidental circumstances. That not uncommon order of some regions commencing by the emission of basic rocks that become more and more acid and then, after an interval, terminate by a final phase of very basic rock, is quite explicable on this hypothesis. Let us imagine a great laccolite of an acid rock taking up its position among limestones. During a considerable period interaction takes place and a peripheral layer of basic rock is formed, being naturally basic at the surface near the limestone. This outer layer also becomes more and more aquiferous by the assimilation of H_2O from the enclosing rocks, until its tension rises enough for it to burst its way to the surface. The first outpour will be eminently basic, but as this drains off, the more and more central and acid layers will rise and follow. When sufficient has escaped to reduce the tension of the whole laccolite, and this becomes so viscous as to be unable to issue, the volcano will become quiescent, during which basification of the acid rock and absorption of H_2O will still progress, rendering it more fusible, and then, becoming more fluid

[8] *Proc. Geol. Soc.*, 1888, pp. 94–96, and *Trans. Edinb. Geol. Soc*, vol. vi., p. 314, 1893.

and of higher tension, it will burst forth, forming the final phase of the volcano.

What may be the composition of the fundamental paste is still an open question, but I believe that it differs in different regions, so that in one volcanic province potash may be a dominant alkali, and in another soda, and so on. So far as my own individual opinion goes, I believe it was a rather acid rock, corresponding to a trachyte, and that either extremes have been caused by chemical alteration.

In fine, I do not deny that the modern hypotheses may each in part explain the cause of differentiations of pastes, but I do maintain that neither the "focal diffusion," "segregation," nor "sedimentation" processes are sufficient by themselves to do so.

H. J. JOHNSTON-LAVIS.

SOME NEW BOOKS.

THE MACLEAY MEMORIAL VOLUME, edited by J. J. Fletcher. Published by the Linnean Society of New South Wales. Pp. lii. and 308, frontispiece, and 42 plates. 4to. Sydney and London: Dulau & Co., 1893. Price 3 guineas.

SIR WILLIAM MACLEAY, who died on December 7, 1891, in his seventy-second year, was pre-eminently the patron of Natural Science in Australia. To his efforts were largely due the foundation and continuance of the Linnean Society of New South Wales, and to commemorate his munificence that Society now issues the present handsome volume, to which naturalists from various parts of Australia and New Zealand contribute a somewhat heterogeneous assemblage of articles of very various value.

The editor, Mr. J. J. Fletcher, prefaces the volume with an interesting account of the Macleays, and especially the eponymous William. As characteristic both of the man and of his biographer's literary style, the following description of an encounter with outlaws in 1864 may be quoted:—"His courageous conduct on this occasion and his commendable example in successfully asserting, rifle in hand, his right to travel on the high road when three desperate ruffians, Gilbert, Hall, and Dunn, one of them a recent murderer of police, held possession of it on the hill overlooking the inn, and having just finished with the Goulburn coach were actively engaged in the process of 'sticking-up' several teams and a number of travellers when Sir William, accompanied only by a boy who was driving the buggy, came on the scene and raised the siege, afterwards received official recognition by his being chosen one of seven gentlemen to whom in 1875 the Government awarded gold medals 'granted for gallant and faithful services' rendered during the period when bushranging was rife."

Professor W. B. Spencer contributes to our knowledge of *Ceratodus* a very thorough account of the blood-vessels of that interesting lung-bearing fish. He finds that both veins and arteries, while showing unmistakable connection with primitive shark-like types, have developed to a certain extent along lines parallel to those of amphibians. He considers that in the earliest forms in which lungs were developed for respiration, the mode of life was very similar to that of *Ceratodus*. The animal lived in water, and, at first at any rate and possibly for long, the lungs were only accessory to the gills. This condition is paralleled in the early life of the frog. In *Ceratodus* the lung is always in use, although the animal does not, as some have supposed, emerge from the water; but this organ is chiefly of service when the river water is thickly charged with sand or fouled by decomposing vegetation. The paper is illustrated by five plates in Mr. Spencer's admirably clear, though somewhat over-diagrammatic, style.

Captain F. W. Hutton follows with a systematic account of the Pliocene Mollusca of New Zealand, which he characterises as "the

remains of an earlier fauna disappearing rapidly before the conquering host of the recent fauna, which had invaded New Zealand some time previously; and if this idea is correct we might expect to find some of the Pliocene forms, which are now extinct on the shores of New Zealand, still lingering in the outlying islands." This appears to be the case, but further investigation is necessary. We hope that the four plates accompanying the paper will be more satisfying to the eye of the conchologist than they are to that of the artist.

Professor W. A. Haswell monographs the Temnocephaleæ, a peculiar group of worms parasitic on the outer surfaces of many kinds of water animals, to which they adhere by a sucker. Like those of most parasitic forms, the affinities of this group are hard to determine. The author concludes that they are probably Trematode rather than Turbellarian, although he sees little reason against regarding them as aberrant Rhabdocœlous Turbellaria, specially modified for a peculiar mode of life. Mr. Haswell also describes, as *Actinodactylus*, a new genus of flatworm, found on the burrowing crayfish of Gippsland; its most remarkable feature is a retractile proboscis. This author's seven plates, drawn by himself, are both clear and artistic.

Professor T. J. Parker and Josephine Gordon Rich describe the muscles of the New Zealand sea crayfish (*Palinurus edwardsi*), a piece of work that should prove of service to Australasian students of the Crustacea. Their chief conclusion of general importance is that "the great ventral mass of muscle in the abdomen, usually considered to act exclusively as a flexor, gives rise to slips which, being inserted into the terga of the segments above the hinges, and pulling in an almost horizontal direction, must act as extensors." The drawings are remarkably clear.

In the course of two papers, Messrs. J. T. Wilson and C. J. Martin show that the name "duck-bill" as applied to Ornithorhynchus is somewhat erroneous, since the muzzle of that animal is neither horny nor even leathery, but covered with a soft skin, like that of a dog's nose, richly supplied with sensitive organs of touch. The object of this is evident when we remember that the animal usually procures its food by raking away in the mud at the bottom of rivers for small larvæ, shell-fish, insects, and worms. The snout is supported by cartilage, which the authors regard as a persistent prolongation of the embryonic cartilaginous skull. The papers are illustrated by five plates containing some excellent micro-photographs.

Professor R. Tate endeavours to show, from an examination of the floras, that Norfolk and Lord Howe Islands are connected with the New Zealand rather than the Australian region, a conclusion that harmonises with the results obtained from the birds and land-shells.

Mr. R. Etheridge, jun., contributes an interesting description of some of the implements and weapons of the Alligator tribe, Port Errington, N. Australia, which were sent to the Chicago Exhibition.

Eighty-two species of Nematode worms, mostly Australian and Fijian, are described by Mr. N. A. Cobb. About half the species are new, and considerable attention is paid to anatomical details. Many of these worms are hurtful to vegetation, and the paper may, therefore, prove of economic importance; otherwise it contains little of general interest.

The volume also contains notes by Baron von Müller, Mr. J. H.

Maiden, and Mr. C. Hedley. Besides being a worthy memorial of a notable man, it does great credit to the Linnean Society of New South Wales, to the printers and lithographers of Sydney and Melbourne, and to all our Australasian colleagues.

[THE EARTH BEFORE THE APPEARANCE OF MAN.] La Terre avant l'apparition de l'homme. Périodes géologiques, Faunes et Flores fossiles, Géologie régionale de la France. By Fernand Priem. Pp. 716, text illustrated. Large 8vo. Paris: Baillière & Sons, 1893. Price 12 francs.

THIS volume forms part of a series entitled *Merveilles de la Nature*. As one of these marvels a restoration of *Triceratops* now graces the title page; but the author might very well have placed his own portrait there instead. For, only last year he produced a companion volume, *La Terre, les Mers et les Continents*, noticed in NATURAL SCIENCE, vol. ii., p. 314, and now he has given birth to the present monster, which contains more matter than 13 numbers of this Journal. The explanation of course is that these volumes are little more than compilations from well-known works in other languages, such as Neumayr's *Erdgeschichte* and Suess's *Antlitz der Erde;* and as such they demand little notice from us.

In some respects Mr. Priem essays to do for the French public what Canon Bonney has done for our own in the book reviewed last month. His descriptions are, however, far more technical and he nowhere achieves that distinction of style so characteristic of the English writer. This one would expect to militate against the popularity of his work, did one not know how much greater the acquaintance of the ordinary Frenchman with such matters is than that of the ordinary Englishman. On the other hand, if Mr. Priem's book is intended for serious students, it is by no means careful enough. Facts of which he was ignorant when he wrote *L'Evolution des Formes Animales* in 1890, he remains ignorant of to-day, through no fault of his critics (see *Geol. Mag.*, Dec. III., vol. viii., p. 515: 1891).

It is, however, only the first 453 pages of the present volume that are devoted to the popularisation of geology. The latter part, which is far more valuable to the world at large, consists of an account of the geology of France. The method adopted, which is the most useful one for the foreign visitor, is to describe the various regions rather than the formations. First is described the Central Plateau, then follow the Western Massif, Ardenne, the Vosges, the mountains of Maures and Esterel, the Alps, the Jura, the Pyrenees, the Sub-Pyrenean plain, the Paris Basin and, lastly, the Basin of the Saone and Rhone. This part is illustrated by numerous maps and sections, and supplies a want, which, so far as we are aware, had not been previously filled. It can hardly be called a pocket guide; at the same time our readers will be glad to learn that the work has been published in 24 Series at 50 centimes, and in 4 Fascicules at 3 francs, and that each series or fascicule may be bought separately. For this last fascicule, at least, we predict a good sale.

As a picture-book the whole volume may attract some attention, since it contains no less than 900 figures. All, however, are not equally good. Most of the interiors of Brachiopods are wooden in the extreme. *Dinornis parvus* has a miserable appearance. Fig. 637, *Megatherium*, fig. 624, the Mammoth, and fig. 355, a Pterodactyl, would have been destroyed long ago by any right-minded person, so full of errors are they. Some of the blocks seem to have been put into a lucky bag, and drawn out at hazard at the last moment; thus

we find *Osteolepis* masquerading as *Holoptychius* (fig. 164), while *Holoptychius* poses as *Osteolepis* (fig. 166); *Ctenodus* has lent his lower jaw to *Dipterus*, while *Coccosteus* and *Cephalaspis* have jumped into one another's shoes. It is to be hoped that no satire is meant when the author ascribes all these wrong determinations to Traquair. But Ammonites as well as fish have gone astray, so that on page 235 *Schlotheimia* and *Arietites* have changed places. Presumably Mr. Priem was already engaged in further stupendous labours that prevented him from seeing this work through the press. The man that takes all the world as his oyster will inevitably suffer from indigestion.

F. A. B.

SUICIDE AND INSANITY. By S. A. K. Strahan, M.D. 8vo. London: Swan Sonnenschein & Co., 1893.

THIS book, which Dr. Strahan calls a "Psychological and Sociological study," has been written to teach a lesson and to prove a theory. The lesson is one of charity and a broader sympathy with self-destroyers than the Church, and consequently public opinion, inculcate. The theory is one that has been gradually shaping itself in the minds of thinkers and gives the lie to the formal coroner's verdict, "Suicide while temporarily insane." Dr. Strahan divides suicides into two classes, Rational and Irrational. To the former belong those whose sanity has never been called in question. To the latter belong the vast proportion of those whose deaths are daily recorded in the newspapers or the registers of prisons and lunatic asylums, and are attributed to mental derangement. It is this class, naturally, that is subjected to physiological analysis. In a very lucid exposition of the causation of suicide, Dr. Strahan proves that suicide is no more an effect of insanity than are the criminal or homicidal impulse, epilepsy or alcoholism, but is, with these, a special manifestation of degenerate vitality of the race. In a tainted family we see, side by side with insanity and epilepsy, the predisposition to suicide. Each is a special form independent of the others, although a combination is frequently found in the same case. Starting from the two fundamental instincts of animal life, self-preservation and procreation of species, Dr. Strahan shows that voluntary death, being a confession of the absence of the former of these instincts, "becomes merely one of the eliminative processes of Natural Selection." In aiming at a popular style, the author sometimes seems to fall below the dignity of scientific dialectics. To give footnote references to well-known Shakesperian quotations, for instance, lends an unpleasant suggestion of amateurishness in literary work. This fault, and an unfortunate misprint, "*æsthetics*" for *anæsthetics* (p. 212), it would be well to remedy in a second edition. But these minor blemishes are lost in the soundness of Dr. Strahan's argument and the earnestness of his purpose. On the whole, his book is the most significant one yet written on the subject.

THE DISPERSAL OF SHELLS. By H. W. Kew, with a preface by A. R. Wallace, F.R.S., etc. (International Scientific Series.) London: Kegan Paul, Trübner and Co., 1893. Price 5s.

IN recommending this book to the public, Mr. Wallace, in our opinion, says rather more than is necessary. Many books, he remarks

in effect, even when full of descriptions of scores of new species with anatomical details to match, and worked out in the most elaborate and accurate fashion, are of less interest to the philosophical naturalist than Mr. Kew's little book. Now Mr. Kew's book is the work of a diligent collector of facts bearing upon the means of dispersal possessed by land- and fresh-water Mollusca; the facts are some of them new, but the general gist of the book is far from new; it is merely a slight extension of a matter which, in its main outlines and even in details, is already well-known. A naturalist, moreover, whose interests are limited to the phenomena of Distribution—important though that subject is—can hardly be called a "philosophical naturalist." If Mr. Wallace had not directly challenged comparison, we should have contented ourselves with an expression of opinion that Mr. Kew has done an extremely useful piece of work. But we must say now that it is neither highly original nor abounding in new and important truths. The fact of the matter is, that the kind of naturalist to whom Mr. Wallace refers when he uses the expression "philosophical," is apt to be alarmingly unacquainted with the structure of animals, and to be a dabbler in what is generally known as bionomics. There is a tendency, which we deplore, to unduly exalt trifling observations upon the "habits" and "intelligence" of animals. To make such observations needs comparatively little knowledge; to write monographs like those which Mr. Wallace passes over so lightly, needs not only skill of eye and hand, but wide knowledge, and, above all, reasoning power and a sense of proportion. We are far from thinking otherwise than well of Mr. Kew's book, but it is not exactly epoch-making.

ROMANCE OF THE INSECT WORLD. By L. N. Badenoch. London: Macmillan and Co., 1893. Price 6s.

THIS is a nicely got-up little book describing in a pleasant fashion some of the more familiar facts about insects. It is not quite obvious why what the author has to tell us should be deemed worthy of gilt edges and cloth sides; we should have thought that a magazine article or two would have sufficed to unburden the writer of his accumulated stores of information. A deliberate book calls for some special acquaintance on the writer's part with the subject upon which he proposes to enlighten his readers; but there is not much evidence of such a special—or, indeed, even a more general—knowledge in this work. The author should not venture upon the quicksands of technicalities without some more defensive protection in the way of fact than he appears to possess. Insects, for example, are defined as "animals formed of a series of rings or segments." This is, doubtless, perfectly correct; but the definition is truly, as he terms it, "broad." It is equivalent to defining man as an animal with a backbone. The concluding section deals with a much debated matter—the questions of "protective resemblance," "mimicry," etc. But Mr. Badenoch evidently has not the slightest idea that there are any debated points relating to the facts which he so glibly sets down. The facts, too, are of the most worn-out character, which have done duty again and again. Those over-worked Heliconidæ cause the gorge to rise in more than one sense. Mr. Badenoch seems to have read Mr. Poulton's "The Colour of Animals," but he should also have consulted Mr. Beddard's "Animal Colouration," which has at least the merit of impartiality. A "Glossary" at the end of the book contains definitions "of the principal scientific terms used." It may be necessary, though we

should have doubted it, to inform the reader that *concentric* signifies "having one common centre"; but surely even the most benighted of "general readers" knows what *oval* means. If he does not he will not get very accurate information from Mr. Badenoch, who considers that it is the equivalent of "oblong"!

PÊCHES ET CHASSES ZOOLOGIQUES. Par le Marquis de Folin. Bibliothèque Scientifique Contemporaine. Pp. 330, 117 figures. Paris: J. B. Baillière et Fils, 1893. Price 3fr. 50c.

THIS is a charming little book on natural history, illustrated by quaint pen and ink sketches of animals, places, and apparatus. It is designed evidently to interest the amateur in the familiar objects of the animal world, and to guide him in the methods of looking for and capturing animals and plants. The reader is first taken to the sea-shore, and when he has spent an hour at the limits of the receding tide, his whetted curiosity is taught to satisfy itself with drag-nets and tow-nets. Thereafter he works his way through Algæ and Fungi and Flowering Plants, and then up through the animal kingdom from Infusoria to Mammals. Excursions to the bottom of the sea, discussions of phosphorescence and of animal electricity, enliven his progress, and a great deal of accurate classification and external anatomy is administered to him in gentle doses. A special and most valuable feature is that the book deals, so far as possible, with exact places, the special features of which are described, and the animals which may be found there specially mentioned. It is a book to be commended to local natural history societies for its method and treatment.

OUTLINE OF THE GEOLOGY AND PHYSICAL FEATURES OF MARYLAND, with a coloured geological map of the State and 16 plates and charts. By Professor G. H. Williams and Dr. W. B. Clark. 4to. Pp. 67. Baltimore: Johns Hopkins Press, 1893. Price $1.

THIS is an extra edition of the description of the Physical Geography and Geology of Maryland recently prepared for the World's Fair Book on the State's resources. It embraces the topography, climate, geology of the plateau, mountain and plain, and a brief account of the distribution of mines and minerals. This text is illustrated by a new geological map of Maryland, six coloured charts to show the distribution of rainfall and temperature, and ten full-page plates of various types of scenery having a topographic or geological significance.

The map, which is on a scale of 1:500,000, approximately eight miles to the inch, represents in twenty-nine colour distinctions the present state of our knowledge of Maryland's geology, and the harmonious arrangement of these colours renders it a most pleasing specimen of chromo-lithography. It is based upon the work of Tyson, I. C. White ,Geiger, Keith, Darton, and G. H. Williams, and contains much information never before published. It is accompanied by a tabulation of the soils belonging to the different geological formations by Professor Milton Whitney.

The work may prove of some general interest, since the State of Maryland contains geological formations in almost unbroken sequence from Archæan to Recent. The ancient crystalline and semi-crystalline rocks of the Piedmont plateau appear to be metamorphosed rocks of Archæan, Cambrian, and Ordovician age. Fossils, it is true, have not been found, neither is there any direct evidence of their sedimen-

tary origin, beyond the fact that beds of different composition rapidly alternate, and have marbles and quartz-schists intercalated. The Appalachians and Alleghanies consist of folded Palæozoic rocks, from Cambrian to Carboniferous, with older eruptive rocks in places. The eastern part of the State is known as the Coastal plain, and is composed of slightly consolidated rocks of Cretaceous and Tertiary age. The numerous unconformities which these present are evidence of successive periods of elevation and depression. English students of the Tertiary rocks would be interested in the highly fossiliferous Pamunkey and Chesapeake formations, which contain many species of mollusca hardly to be distinguished from our own.

The charts are based upon a full investigation of all data relating to the climate of Maryland. Much information has been gathered on this subject, especially since the organisation of the State Weather Service, and these charts and the accompanying tables of observations, now for the first time bring the results together in a compact form. The climate, like the surface of the country, is greatly diversified, and the comparisons instituted will prove of interest to meteorologists. We miss, however, the promised section on Medical Climatology.

The style of the work is to be commended for its clearness and conciseness; it will probably obtain for it more readers than would have been found for a more ambitious and more technical description. After all a scientific work may be intelligible sometimes.

We may also add that we have received a "Guide to Baltimore," originally prepared by a local committee for the use of the American Institute of Mining Engineers at their Baltimore meeting. This contains an account of the geology of Baltimore and its vicinity, more detailed and more special than that in the work just reviewed. The account of the crystalline rocks is by Professor G. H. Williams, and that of the sedimentary rocks by Mr. N. H. Darton. This book is accompanied by two of the Geological Survey maps of the neighbourhood—one bringing out the features of the crystalline, and the other those of the sedimentary rocks.

F. A. B.

The Mineral Resources of Western Australia. By Albert F. Calvert. Pp. 179. London: George Philip & Son, 1893. Price 2s.

Western Australia comprises about one-third of the great island-continent, but it is a colony which is said to have "slumbered for over fifty years." It is now slowly waking up, though its population in 1891 was estimated at a little under 50,000 persons, exclusive of Aborigines; or one individual to about every twenty square miles. There is room therefore for some of the unemployed who are prepared to do hard work in return for a moderate income; and there is room also for the capitalist whose aim would be to assist in developing the resources of the country, without seeking to make enormous profits. The colony is not well off for water; but this present drawback to progress can be overcome by the construction of reservoirs and the sinking of deep wells.

In the little volume before us Mr. Calvert gives accounts of each of the gold-fields of Western Australia; a subject which occupies the greater part of this work. In addition, there are brief notes on tin-fields, the Collie coal-mines, etc. He acknowledges assistance from the reports of the present Government geologist, Mr. H. P. Woodward, and of his predecessor, the late Mr. Hardman, in whose reports

full particulars of the known mineral resources of the colony will be found.

There is no doubt that rich gold-fields exist, some of unknown extent, but enterprise has been arrested by the scarcity of water, and the want of railway communication.

WOODWARDIAN MUSEUM, CAMBRIDGE.—CATALOGUE OF THE FOSSILS IN THE STUDENTS' STRATIGRAPHICAL SERIES. By H. Woods. 8vo. Pp. 24 (interleaved). Cambridge, 1893.

THIS little pamphlet contains a list of the typical fossils of each formation, together with a note as to their class or order. We recall a collection of a similar nature in the Edinburgh Museum, which has been arranged by Mr. Goodchild, and at the present moment Mr. Etheridge is soliciting specimens for a like purpose in the British Museum. We would suggest that Mr. Woods, in his next edition, might add the authors' names to the species, for it is most important that the student should be trained to associate the literature of the fossil with its name.

LIEFERUNGEN 7 to 9 of the new edition of the Molluscan portion of Bronn's "Klassen," edited by Simroth, have just lately been received. They contain the completion of the Aplacophora and the first few pages of the Polyplacophora.

The following is the author's subdivision of the former order so far as the families are concerned :—

SUB-ORDER.	FAMILY.
I. Chætodermatina	1. Chætodermatidæ.
II. Neomeniina	1. Neomeniidæ 2. Proneomeniidæ 3. Dondersiidæ 4. Parameniidæ

We regret, however, to notice that new genera, subgenera, and even species are introduced and not always fully described. New forms, even in such a small group as this, should, we venture to think, be previously described elsewhere: their inclusion in the first instance in a work of this character, where they are out of harmony, is a mistake, and unnecessarily complicates the subject-matter, which should be kept strictly to its proper broad lines.

VERY useful to students of Ammonites is a pamphlet by Dr. J. F. Pompeckj (Beiträge zu einer Revision der Ammoniten des Schwäbischen Jura. Lief. i. Stuttgart: E. Schweizerbartsche Verlagshandlung, pp. 1–94, pls. i.–vii., 1893). This is nothing less than the translation of the remarkable trinomial and sometimes quadrinomial nomenclature, employed by Quenstedt in his great works on Ammonites, into the modern system. Thus, *Ammonites angulatus intermedius gigas*, as Quenstedt named one important species, is concisely rendered into *Schlotheimia intermedia*. The present part deals with the genera *Phylloceras*, *Psiloceras*, and *Schlotheimia;* and besides the translation of its name, each species is critically considered, and mistakes in identification corrected; while new species of Swabian Ammonites are described. Future instalments of the work will be awaited with interest. We only hope that the author will not treat *Arietites*, which he incidentally mentions, as a valid genus. It is forestalled by Hyatt's *Arnioceras*, *Coroniceras*, etc., whose

limits and characters are distinctly defined, on correct morphological principles, in that author's "Genesis of the Arietidæ" (*Smithsonian Contrib.*, 673).

THE *Società Malacologica Italiana* has published in its *Bolletino* (xviii., pp. 73–108) a paper by Guido Bonarelli, which is of considerable value to students of Ammonites, being a descriptive catalogue of over thirty species, which the author unites under the new generic name *Hecticoceras*. The type-species of the genus is *A. hecticus*, Reinecke, while *A. lunula*, Reinecke, serves as type-species of a subgenus *Lunuloceras*. It is to be hoped that these new genera will prove to have been formed better than their names. Professor Bonarelli considers that *Hecticoceras* belongs to the family Oppelidæ, and that it was derived from *Oecotraustes*. This opinion is probably correct; but then *Oecotraustes*, as at present constituted, includes rather a heterogeneous assemblage of Oppelidæ, and would, in fact, form a worthy object for the learned author's further investigations. Meanwhile, the present paper marks one more forward step towards the true classification of the Ammonites.

THE Royal Scottish Geographical Society's Atlas of Scotland is announced to be published by the Edinburgh Geographical Institute (J. G. Bartholomew & Co.) next June. It will comprise a series of sixty-two plates of maps and plans, illustrating the topography, physiography, geology, natural history, and climate of the country; these being accompanied by an explanatory and statistical text. The completion of the publication of the Ordnance Survey Maps, the advanced progress of the Admiralty and Geological Surveys, and the large collection of data, produced by the recent activity of Scottish scientific societies, in the departments of Meteorology, Natural History, and Archæology, seem to make the present time most favourable for the production of an Atlas in which that valuable work shall be summarised and incorporated.

IN NATURAL SCIENCE, vol. ii., p. 385, we noticed M. Guinard's book, "Précis de tératologie"; we have now received a smaller volume, by Louis Blanc, "Les Anomalies chez l'homme et des mammifères" (Ballière, Paris, 1893, 328 pp., price 3 fr. 50), in which the student will find a great amount of useful and interesting information. The volume is fully illustrated.

IN referring last month (p. 77) to Mr. Minchin's translation of Professor Bütschli's work on Protoplasm, we erroneously ascribed its publication to the Clarendon Press. English-speaking students are indebted to the firm of Messrs. A. & C. Black for this enterprise, and the volume will probably be issued early this month.

CAPTAIN H. G. T. SWAYNE, who has made seventeen shooting and exploring trips into Somali Land, North-East Africa, is writing an account of the country, which will shortly be published by Rowland Ward & Co., of 166 Piccadilly, W.

MESSRS. DULAU & Co. have issued part xxxi. (Reptilia and Amphibia) of their Catalogue of Zoological and Palæontological Works. Numerous rare pamphlets are included in this useful sale-catalogue.

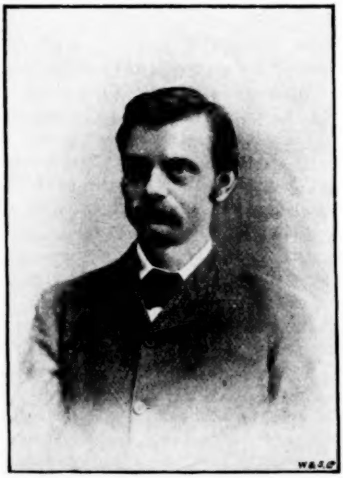
OBITUARY.

ARTHUR MILNES MARSHALL.

Born June 8, 1852. Died December 31, 1893.

THE Owens College and the Victoria University have suffered, by the sad death of Professor Marshall, an irreparable loss; in him they have lost not only one of their most brilliant professors, but also one of the most loyal of their servants.

Ever bright and cheerful, no difficulty ever daunted him, and no amount of work appeared to be too much for him. He was one of



ARTHUR MILNES MARSHALL.

(From a photograph by Warwick Brookes, Manchester.)

those rare men who are always working and never tired, although they do more work than any average man could do in twice the time—always busy, but never too busy to give help to those who needed it. His clear insight into the practical problems which had to be solved, combined with unusual foresight and tact, enabled him to avoid the difficulties in which others were constantly entangled; but when a serious difficulty was actually encountered, no man was more

ready than he to attack it or give his aid to those by whom it had to be faced.

The obstacles which have to be surmounted in the founding of a university are familiar to those who have exerted themselves to promote the schemes for the foundation of the Victoria University, and of a teaching university for London, but those obstacles present very different aspects to the two bodies of men. When the difficulty has been overcome, the contemplation of it becomes a source of pleasure instead of a cause for anxiety. To Marshall, a difficulty ahead served as a pleasant stimulus; he rejoiced in overcoming difficulties, just as he rejoiced in climbing a mountain peak. Cautious and expert as a mountaineer, caution and expertness enabled him to contemplate a great difficulty, if not with pleasure, at least, without fear. Difficulty as a matter of history was familiar to him: unconquerable difficulty almost unknown. And to this, no doubt, his perennial happiness was largely due, for he was always happy.

Too clear-sighted not to see what was his own personal interest, he did not hesitate to sink that interest when it was necessary for the success of the undertaking; and the readiness and cheerfulness with which he did it led others to promptly make similar sacrifices. But he did not regard them as sacrifices, for his great aim was never personal gain, and he had the good fortune to be associated with others who equalled, though they could not surpass, him in unflinching loyalty to the College, to the new University, and to the cause of higher education generally.

The success of the Victoria University Extension movement has been due largely if not mainly to his efforts and his great power of organisation, and especially to his tact in adjusting conflicting interests. He thoroughly believed in the usefulness of the extension scheme, and threw himself heartily into the work—and the scheme has succeeded. He did not make it a success single-handed, but those who co-operated with him did so the more heartily because of his encouragement.

Many of the zoologists who knew him, and probably they alone, looked with disapproval upon this expenditure of his time—the energy did not much matter, for he seemed to have an unlimited supply of it. From a purely zoological point of view, this organising work was no doubt a loss to science. He himself ardently wished to find time for more scientific work, and he had at the time of his death already made preparations for new and elaborate researches. He was, however,—as befits a professor—always ready to devote his time to helping others in any kind of biological research.

Two volumes of "Studies from the Biological Laboratories of the Owens College" have already been published, and it was intended to publish another very shortly. Of the twenty-one papers included in these two volumes only four were prepared without his aid and inspiration, and of these three are botanical.

His enthusiasm was infectious, and he attracted large audiences to his popular lectures—audiences composed chiefly, not of "those who with itching ears run about after popular preachers," but of those who had been inspired with interest in biological science by his previous lectures.

The Manchester Microscopical Society, of which he was president for the last seven years of his life, is composed of enthusiastic naturalists, and it is largely because of the earnestness which his example has called forth that wealthy mill-owners and justices of the peace sit in the meetings of the society, unconscious of social inequality, cheek-by-jowl with poor men who work for a weekly wage; and to that same beneficent influence may be ascribed the fact that, under the auspices of the society, systematic courses of biological instruction are undertaken by teachers whose services are given gratuitously and willingly.

Marshall was only 41 years of age, and there was every reason to believe that in the next few years he would have accomplished far greater scientific work than he had as yet done; but there are few men who have done so much for the advancement of education in so short a time as he has, and yet have found time for even a little scientific work—and his scientific work is more than a little.

Like his friend, F. M. Balfour, who met with a similar untimely death on the mountains, he was a keen embryologist. He thoroughly believed in the theory of "recapitulation," and never lost an opportunity of convincing others of its truth. At Leeds, in 1890, he said:—

"That ontogeny really is a repetition of phylogeny must, I think, be admitted, in spite of the numerous and various ways in which the ancestral history may be distorted during actual development."

That sentence expresses the belief which formed the basis of his teaching. That theory was the source of the inspiration under which his latest published work was written, *i.e.*, his "Vertebrate Embryology," published only a few months before his death.

Of that work no review has appeared in the pages of NATURAL SCIENCE, but Professor Lankester, in reviewing it in *Nature*, says:—"It is not too much to say that he has produced a most valuable, clear, and masterly exposition of the known facts of the developmental history of leading types of vertebrata." It may be added that the book is very liable to give the impression to the reader that it is chiefly a compilation. But this is not correct. He repeated the observations of his predecessors wherever it was possible to do so, and published the results. It is not surprising that his predecessors were often right, and where they were right, he reproduced their accounts, and even their figures. Many of the figures, however, were corrected before they were reproduced, and the book contains

considerably more than a hundred new ones, drawn by the author himself direct from nature.

Like other books which Marshall published either alone or conjointly, this was intended as a laboratory manual, and hence the "type system" had to be adopted; but it was really adopted for another reason. He was keenly alive to a source of error which is too commonly ignored—the assumption that what is true of one animal is true also of its allies, or nearly so. It is this assumption which seems to be taken implicitly as a justification for the description of changes in the course of development of man, which, whether they occur or not, have not been seen by those who have described them, or by those who have been quoted. It is this, also, that leads to the wholesale illustration of books on human anatomy by figures intended to illustrate the structure of man, though they have been drawn from animals sometimes as unlike man as dogfishes and birds. "Comparative Embryology" is one thing: the indiscriminate confusion of the embryonic development of one animal with that of another is another thing altogether. Marshall has produced the first book on the development of man and other vertebrates which is free from this confusion. He felt strongly the necessity for having a straightforward description of the development from beginning to end of a few typical vertebrates before attacking anew the larger problems of comparative embryology. That he did not live to attack anew those larger problems is a pity too sad for expression in words.

Besides this great embryological work, he published, alone and conjointly with others, several papers on vertebrate morphology, and especially on the morphology of the head. Other papers dealt with the development of the kidneys and fat-bodies, the abnormal conditions of the reproductive organs, and the development of the blood-vessels of the frog.

His chief invertebrate work was upon the Pennatulida, and one of the papers on this subject was written in collaboration with his father. He worked also upon the structure and physiology of *Antedon* (*Comatula*), and published a paper on its nervous system.

His published lectures and addresses are numerous, the presidential address to the Biological Section of the British Association (Leeds, 1890) and a paper on the morphology of the sexual organs of *Hydra* being, perhaps, the most important of them.

This may seem a small amount of scientific work for a man of his age, but those who knew Marshall best, know best how small a fraction it is of the work he did for the advancement of learning. They who would judge him by his published work would do him a gross injustice.

There is no great scarcity of zoologists who might efficiently perform the strictly zoological work of the professorship, but it is not probable that a successor will be found who is willing to devote so much time and energy to other business of the College and University

as he did. It is even less probable that one will be found who is able to render such services with like tact and good humour.

"Few men have enjoyed life more, still fewer have used it better."

C. H. H.

RICHARD SPRUCE.

BORN 1817. DIED DECEMBER 29, 1893.

THE botanical world has sustained an irreparable loss in the death of the famous botanist and traveller, Richard Spruce, who succumbed to an attack of influenza on the 29th of December last. Mr. Spruce was born in the year 1817, and was a native of the North Riding. It is nearly fifty years since he published his first paper, which dealt with the Mosses and Hepatics of Teesdale. Shortly afterwards he spent a year in the Pyrenees, collecting the flowering and cryptogamic plants of that region; his paper on the Mosses and Hepatics, published in 1849, was a very valuable addition to our knowledge of the European flora. In the same year he went out to South America, and travelled up the river Amazon, making extensive botanical collections. During two years he was, more or less, with Dr. Alfred Russel Wallace; and, when the latter came home, Mr. Spruce proceeded up the Rio Negro, crossed over to the Orinoco, returned to the Rio Negro, and exploring various of its tributaries, gradually made his way up into the Andes. Here he received a commission from the India Office to collect seeds and plants of the Cinchona, which was then rapidly becoming exterminated. In this he was most successful, and hundreds of young plants were safely transferred under the fostering care of Mr. Robert Cross from the western slope of Chimborazo to India, and established in the Himalaya. Mr. Spruce's travels are described at some length in the *Journal of Botany* between the years 1849 and 1864. He returned to England in 1863 a permanent invalid. His collections stand unrivalled, both in the immense number and the beautiful completeness of the specimens. His bad health prevented him from working out more than the Palms and the Hepatics. Mr. Bentham did the Phanerogams; Mr. Mitten the Mosses; the Rev. W. A. Leighton the Lichens; and the Rev. M. J. Berkeley the Fungi. Mr. Spruce's Hepatics of the Amazons and Andes occupies the whole of vol. xv. of the *Trans. Bot. Soc. Edinburgh*, and is a novel and most scientific treatment of the subject. The majority of his other papers were devoted to his favourite study—the Hepatics. The last thirty years of his life, rendered grievous by his chronic state of ill-health, were spent at Coneysthorpe, in North Yorkshire, where he died at the close of 1893, at the age of 76.

ROBERT BENTLEY.

BORN 1821. DIED DECEMBER 24, 1893.

THE late Professor Bentley was born at Hitchin, in 1821. After leaving school he was apprenticed to William Maddock, a chemist at Tunbridge Wells, and, having served his term, became an assistant at the establishment of John Bell & Co., in Oxford Street. He joined the School of Pharmacy in Bloomsbury Square at its foundation, and subsequently entered as a medical student at King's College, becoming, in due course, a member of the College of Surgeons. He commenced the study of botany during his apprenticeship, and when at Bloomsbury attended Dr. A. T. Thompson's lectures, and gained the first botanical prize awarded by the institution. His connection with the Pharmaceutical Society was almost lifelong, and it was to members and associates of the Society that he was best known. In 1887 he resigned the chair of Botany, and was shortly after elected Emeritus Professor. He was also for some time Professor of Botany and Dean of the Medical School at King's College, and Professor of Botany at the London Institution. He was twice President of the Pharmaceutical Conference, at Nottingham in 1866, and in the following year at Dundee, and for many years acted as chairman to the Garden Committee of the Royal Botanic Society, Regent's Park, where he annually gave a course of botanical lectures. His most important scientific work was that on "Medicinal Plants," which he shared with Mr. Henry Trimen, a most valuable book of deservedly wide reputation. Bentley also produced a small text-book on Botany, which passed through several editions, and was the author of numerous papers, chiefly of botanical interest, in the Pharmaceutical Society's *Journal*, the editorship of which he shared for about ten years. He was buried on December 30 at Kensal Green.

We are indebted for several of our facts to an obituary notice by Mr. O. Corder in the *Pharmaceutical Journal* of January 6.

THE deaths are also announced of SIR SAMUEL BAKER, the eminent African explorer; of PIERRE VAN BENEDEN, the veteran zoologist, of Louvain; of DR. J. BOEHM, the botanist, of Vienna, at the age of 62; of BARON KARL VON KÜSTER, the botanist; and of MAJOR JOHN PLANT, late of the Salford Museum. We hope to give some account of the work of SIR SAMUEL BAKER and other recently-deceased African explorers next month.

A LONG obituary notice of the late HENDRIK RINK, by Dr. Robert Brown, appears in the January number of the *Geographical Journal*.

NEWS OF UNIVERSITIES, MUSEUMS, AND SOCIETIES.

The Trustees of the George Henry Lewes Studentship in Animal Physiology, tenable for three years at Cambridge, London, or any Continental University, have elected Dr. John W. Pickering.

Among the lectures in Natural Science at Oxford during this term, the following are announced:—Professor Lankester and Mr. W. B. Benham, an advanced course on Reptiles and Birds; Mr. Benham on the Oligochaeta; Mr. G. C. Bourne on the History of Zoology; Professor Burdon-Sanderson and Mr. J. S. Haldane on the Physiology of the Nervous System; Mr. Haldane on Physiological Chemistry; Mr. E. B. Tylor on Races of Mankind, as classified by Language, Civilisation, and History; Mr. A. Thomson, the new Professor of Human Anatomy, on the Elements of Physical Anthropology as bearing on Classification of Races; Mr. H. Balfour on Progress in the Arts of Mankind, particularly as illustrated by the Pitt-Rivers collection. Professor Green lectures and gives practical instruction in Geology, Professor Vines in Botany, and Mr. M. S. Pembrey in Physiology and Histology, while Mr. Barclay Thompson lectures, as usual, on the skeleton of the Sauropsida.

The Natural History Laboratories of the State University of Iowa started a Bulletin about two years ago, which often contains papers of interest. No. 4 of vol. ii., which has just come to hand, includes "Observations on the development of the *hypophysis cerebri* and *processus infundibuli* in the domestic cat," by F. S. Aby, some papers on Coleoptera by H. F. Wickham, an interesting account of a botanical expedition to Nicaragua by B. Shimek, and studies of Myxomycetes by T. H. McBride. We have been greatly struck by the excellent applications of the half-tone process, sometimes known as "Meisenbach," to scientific illustration, and the plates, especially to the botanical papers, show what this process is capable of when the drawings are properly prepared, and the blocks carefully printed.

Toynbee Hall continues to do good educational work in Natural Science, as well as in the numerous other subjects with which its classes deal. The University Extension courses in connection with this centre are:—"Recent discoveries with the Telescope and Spectroscope," by Dr. A. H. Fison; "The Geology of the British Islands," by F. W. Rudler; and "The Senses and Nerves," by E. A. Parkyn. Classes are also held, in Botany by G. May, in Biology by Miss Mitchell, and in Geology by Miss Raisin, while Miss Hall takes a Sunday class on "Forms of Vegetable Life." The Toynbee Natural History Society announces the following papers:—On February 5, "African Experiences," by Dr. J. W. Gregory; on March 5, "Water Fleas of Wanstead Park," by D. Scourfield; and April 2, "Formation of Crystals in Rocks," by A. M. Davies.

A valuable herbarium has been presented to the Nottingham Natural History Museum by Mr. H. Fisher, late of Newark. Some idea of the nature and

extent of the collection may be gathered from the following enumeration of the more important series included in it: (1) A complete herbarium of British plants, comprising about 2,000 species and varieties, and about 10,000 specimens. (2) A European collection, comprising many thousand species from France, Germany, Switzerland, Austria, Roumania, Russia, Norway, Sweden, &c. (3) Several thousand species from North America. (4) A very fine collection from the Bombay Presidency. (5) About 1,500 species from Natal, the Transvaal, and other plants of South Africa. (6) A small collection from Australia. Of the above collections that from Russia is of quite exceptional value and interest. It comprises species from all parts of the Russian Empire—from St. Petersburg, Lapland, and the Crimea, through Siberia to Kamskatka and Turkestan, also from the Trans-Caucasus and the Caspian region. The Spanish collection is an extremely fine and valuable one—probably one of the best in existence. In order to hand over the collection to the town in as complete and accessible a form as possible, Mr. Fisher is himself arranging and labelling the collection, a work which will take many weeks of continuous application to complete.

THE Royal Irish Academy has issued its *Proceedings* for 1893 (ser. 3, vol. iii., no. 1). Among other papers, it contains a list of the Hepaticæ of the Hill of Howth, by D. McArdle, and two papers by J. E. Duerden; the first on some new and rare Irish Polyzoa, and the second on the Hydroida collected by the Royal Irish Academy Survey of the south-west coast of Ireland, 1885, 1886, and 1888, both of which will be of importance to others besides British marine zoologists. Dr. V. Ball has an interesting article on the volcanoes and hot springs of India, to which we allude in another place.

WE have received the first and second parts of vol. iii. of the *Actes de la Société Scientifique du Chili* (Santiago, 1893). Among other papers in this number are Lataste's "Rhythme vaginale des Mammifères," Germain's "Coleoptères du Chili," and Grez's "Los jeroglificos de la Piedra de la Batalla," and "La Piedra del Olimpo," an interesting account of the picture-writings of the aborigines of Chili, with plates of the inscriptions. The concluding portions of Borne's paper on the spider *Latrodectus*, will shortly appear as parts 4 and 5 of vol. ii., and will complete that volume.

THE Royal Academy of Denmark have published *Oversigt over der K. Danske Videnskab. Selsk. Forhandlinger*, 1893, no. 2, which contains an interesting biological study of the leaf of the South American Vellosiacea, by E. Warming, and a systematic description of the larval forms of the water-insect *Acilius*, by F. Meinert. J. Lange continues his contributions to the Flora of Spain.

THE Wisconsin Academy have just issued vol. ix., part 1, of their *Transactions*. As a contribution to our knowledge of lake faunas, the paper by C. D. Marsh on the Cyclopidæ and Calamidæ of Central Wisconsin will be of importance. The other Natural History papers are mostly lists of local faunas and floras.

AT the fourteenth annual meeting of the Biological Society of Washington, the officers for 1894 were elected, as follows:—President, Professor C. V. Riley, U.S. Entomologist; Vice-Presidents, Dr. F. Baker, Superintendent of the National Zoological Park, Mr. B. E. Fernow, Chief of the Forestry Bureau, Mr. R. Rathbun, of the U.S. Fish Commission, and Mr. C. D. Walcott, of the Geological Survey; Recording Secretary, Mr. F. V. Coville, of the Department of Agriculture; Corresponding Secretary, Mr. F. A. Lucas, of the National Museum; Treasurer, Mr. F. H. Knowlton, of the same institution. The Biological Society is one of the oldest of the scientific societies of Washington, and devotes its meetings to the discussion of original scientific facts rather than to the popular exposition of biology.

THE following awards have been made by the Council of the Geological Society of London, to be presented at the annual meeting on February 16:—The Wollaston Medal to Professor Dr. K. A. von Zittel; the Murchison Medal to Mr. W. T. Aveline; the Lyell Medal to Professor John Milne; the Wollaston, Murchison, and Lyell Funds respectively to Messrs. A. Strahan, G. Barrow, and W. Hill; and a portion of the Barlow-Jameson Fund to Mr. Charles Davison.

THE Committee of the Natural History Society of Northumberland has organised a series of six popular lectures on Natural History, now being delivered on alternate Saturday evenings in the Newcastle Museum. This month Dr. G. S. Brady discourses on Natural History in Norway, and Professor M. C. Potter gives an illustrated lecture on Tropical Vegetation in Ceylon. Subsequent lectures relate to forest trees, the ancestry of the horse, and the history of photography. Mr. A. H. Dickinson has succeeded the late Mr. Dinning as hon. secretary.

THE Palæontographical Society have issued their volume of Monographs for 1893. It comprises instalments of Fossil Sponges, by Dr. G. J. Hinde; Ammonites, by Mr. S. S. Buckman; Cretaceous Star-fishes, by Mr. W. Percy Sladen; and the Devonian Fauna of S.E. England, by Rev. G. F. Whidborne.

AT the moment of going to press we learn of the election of Mr. Henry O. Forbes to the Curatorship of the Liverpool Museum, in succession to the late Mr. T. J. Moore.

CORRESPONDENCE.

Olive-Brown Seaweeds.

In the January number of Natural Science, Miss Barton has set forth exhaustively, if in somewhat severe language, the present state of our knowledge of the development of the cryptostomata and conceptacles of the Phaeophyceæ. I do not wish to dispute any single fact she has mentioned, or to question her presentment of the whole body of them, but since the matter is one of considerable interest, a little further discussion of the bearing of the facts and of her suggested interpretations may be profitable. At first sight, the discussion might appear to wear the aspect of a contention for the shell of a nut, while the kernel is despised—that the contents (when there are any) of these bodies might serve us better for discussion, but I do not find that this view, in effect, has been neglected, though, perhaps, she has presumed the reader to understand more than he commonly does. It might be objected also that this is, to some extent in any case, an affair of growing-points which hardly afford stable characters otherwise in the groups in question. Here, again, one might easily be misled, as there is no diversity of the kind unaccompanied by other characters. A third objection might be raised that, in some of the cases cited, the hairs of the cryptostomata may possibly be discharging the function of absorption, for example, and I may anticipate such an objection by saying that whatever their present function may be, it has little or nothing to do with what the original one may have been, if these are indeed "ancestral structures," as Miss Barton possibly considers them. So far none of these views seriously touch the matter, and I bring them forward to dispose of them merely as a supplement to her article.

I have no doubt merited Miss Barton's criticisms of my contempt for the ancestors of the Fucaceæ, since she shows that some observations of my own might be exhibited as having a genealogical interest in this direction. I think I have spoken of them elsewhere with respect. No one can, indeed, dispute the fact of seaweeds, like other beings, having had ancestors, but my faith has not given me the eye to see these interesting organisms gilded with the romantic attributes that Miss Barton has ascribed to them. Cold facts do not carry us far enough. It may be profitable to ask ourselves the questions with which she concludes her article, but we may also ask them of Nature. We shall certainly get no answer until we do. That may be, and no doubt is, a sententious remark, but without striking too decadent a note, one may at least give warning of the danger of applying such broad principles to an insufficient array of facts. In Miss Barton's case it is, no doubt, a symptom merely of the enthusiasm which will enable her to add to the facts she has already accumulated not the least by her own investigations.

George Murray.

Scientific Volapük.

In your useful article on "Scientific Volapuk," which should, by the way, be "Volapük" (World-speech), you quote Professor Hyatt's terms mostly from *Zoologischer Anzeiger* for August, 1893. You seem to have overlooked the original paper "Bioplastology and the related branches of biologic research" (*Proc. Boston Soc. Nat. Hist.*, vol. xxvi., pp. 59-125), of which the publication was begun in August and completed in September, 1893. Since this paper contains a few terms that you

have not mentioned, I respond to your request for additions by sending them herewith.

Autotemnon (αὐτός, self; τέμνω, I divide), a single free Protozoon, so called in allusion to the common mode of multiplication, and in distinction to *zoön* which is the unit of the Metazoa.

Epembryonic (ἐπί, after; ἔμβρυον, embryo), a term characterising all stages of ontogeny after the embryonic.

Mnemegenesis was less correctly Mnemogenesis in the original paper.

Tachygenesis (ταχύς, quick; γένεσις, formation or development), the phenomenon previously known as "acceleration of development."

Tachygenetic, adjectival form of preceding, applied to normal types in which acceleration of development occurs.

It may also be noted that *Kinetogeny* of Ryder is merely a variant of *Kinetogenesis* of Cope, with the same meaning and corrupt etymology, only more so. Some people are never satisfied.

You are doubtless correct in criticising *Cotype*; for *typus*, though used by the Romans just as *type* is by us, was always regarded by them as a Greek word and they would certainly have used the prefix *syn-*. At the same time Oldfield Thomas is not altogether to blame, since he gives the credit (or discredit) for the word to C. O. Waterhouse, and merely retains for himself the credit of defining it more exactly.

Although one of those who have before now fallen under the lash of your criticism in respect of word-making, permit me to say that with this your last article I fully agree, and especially with the last paragraph of it which relates to the popularising of science. After reading the article that preceded it, I dreamed all night that I was a sorus of plurilocular sporangia and Laminarian paraphyses rolled up in a Fucaceous conceptacle to protect me from the attacks of oogonia, antheridia and filamentous cryptostomata.

F. A. BATHER.

FONA OR FUDDLEITE.—A NEW MINERAL.

A GOOD-NATURED friend has just drawn my attention to the note under this heading which appears in your last issue.

Mrs. French-Sheldon was kind enough to send me a copy of her interesting work, and, like your contributor, I was somewhat amused at, and for a momeut exercised to understand, the extraordinary collocation of symbols which is there made to do duty for the formula of *Trona*, which, in my letter to the fair authoress, I had represented—or perhaps I had better say, attempted to represent—as

$$2\ Na_2O\ 3\ CO_2\ 4\ H_2O.$$

The matter, I think, is hardly worth the space it occupies in a periodical of the dignity and importance of NATURAL SCIENCE; but, in justice to the lady, may I suggest to your contributor, whose acumen would seem to lag behind his sense of humour, that he might exercise, and possibly even improve, his critical *flair* by ascertaining, *currente calamo*, how this expression could be calligraphically transformed into something akin to that which has so greatly puzzled and disturbed him.

T. E THORPE.

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